Chesapeake Bay Program Phase 6 Watershed Model Webinar

Dave Montali – WV DEP – Modeling WG Co-Chair

Gary Shenk – USGS - Chesapeake Bay Program

Matt Johnston – UMd – Chesapeake Bay Program

7/7/16

Partnership Feedback on Modeling

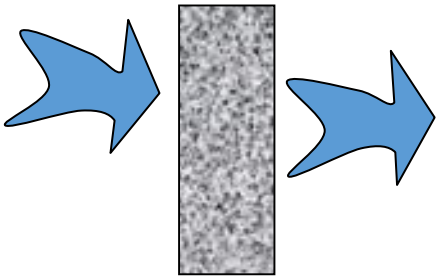
- **Water Quality Goal Implementation Team**
  - Need more transparent and easier to understand decision-support tools to enable successful engagement of local partners

- **Scientific and Technical Advisory Committee**
  - Multiple Models
  - Phosphorus
  - Conowingo
  - WSM and WQSTM reviews coming

Goals for Phase 6

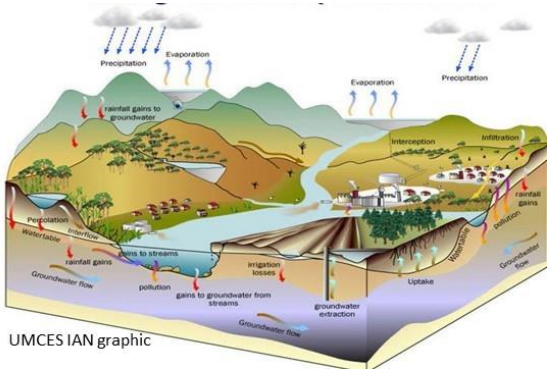
Understandability

Simple explanation
but not content



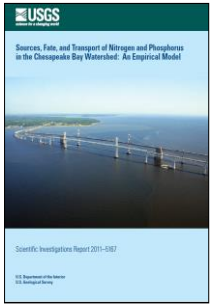
Build upon Current Knowledge

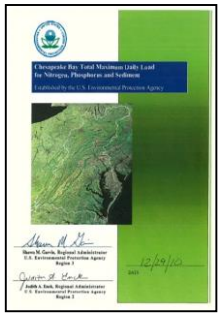
Refined Geographic Scale

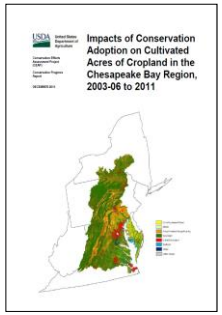


UMCES IAN graphic

Multiple Models





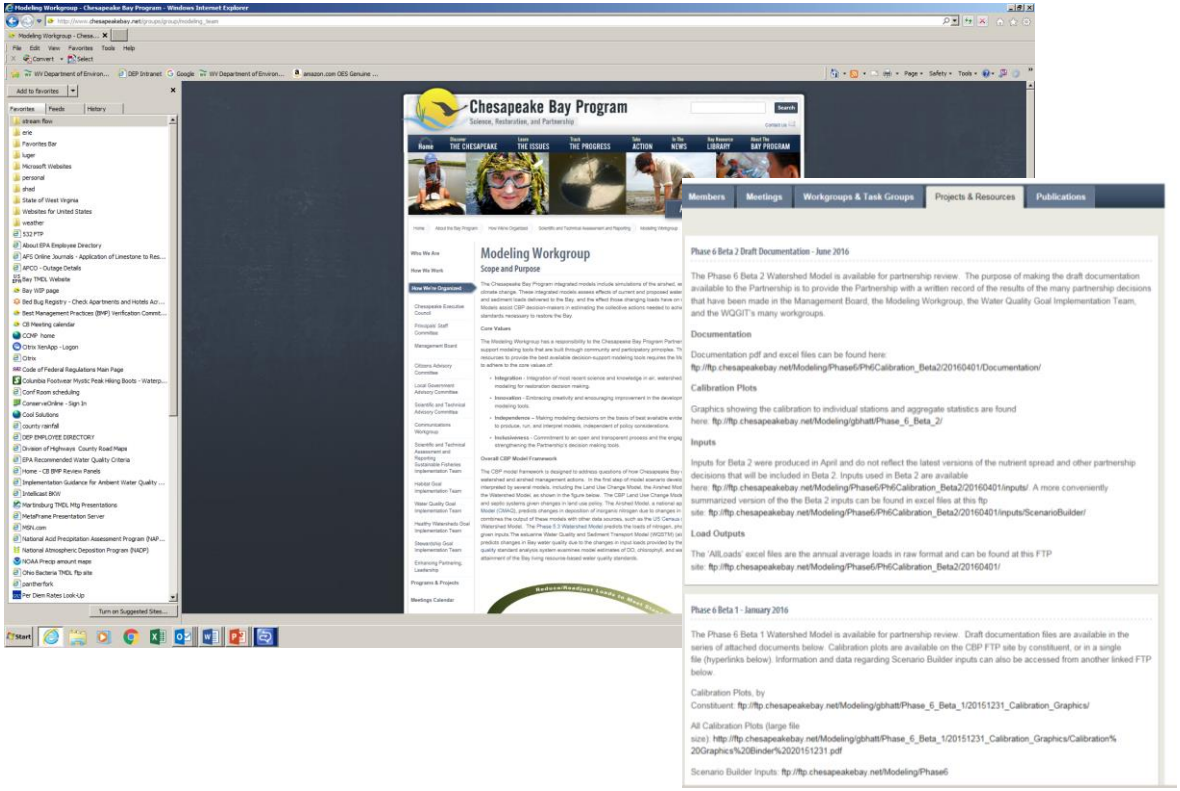


Accessibility

Phase 6 WSM Improvements

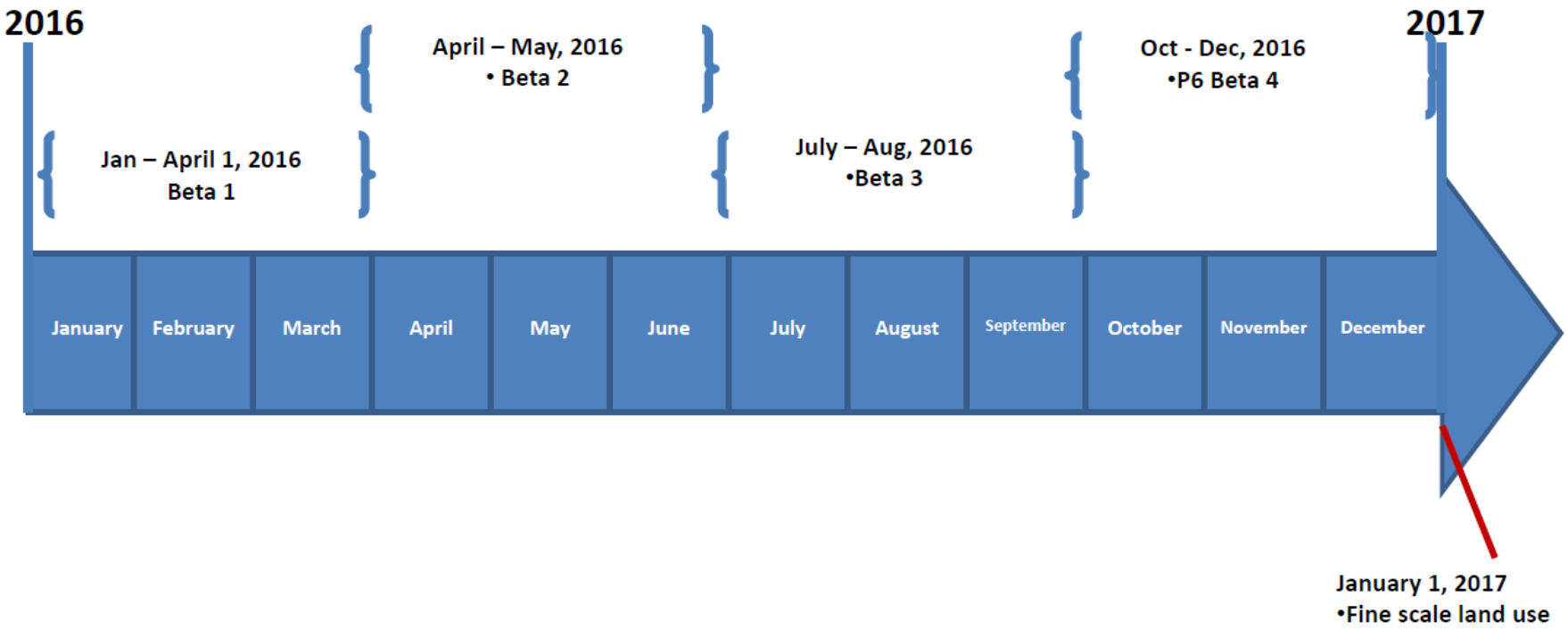
- Extended simulation time period
- More stations and many more observations
- New land uses and relative loading rates from WQGIT WGs
- Improved inputs
- Inclusion of loading lag times
- More transparent N simulation
- New TP simulation approach
- Conowingo simulation
- Reduced dependence upon Regional Factors

Documentation



- See MWG Webpage
- http://www.chesapeakebay.net/groups/group/modeling_team
- Will be periodically updated
- Webinars here too

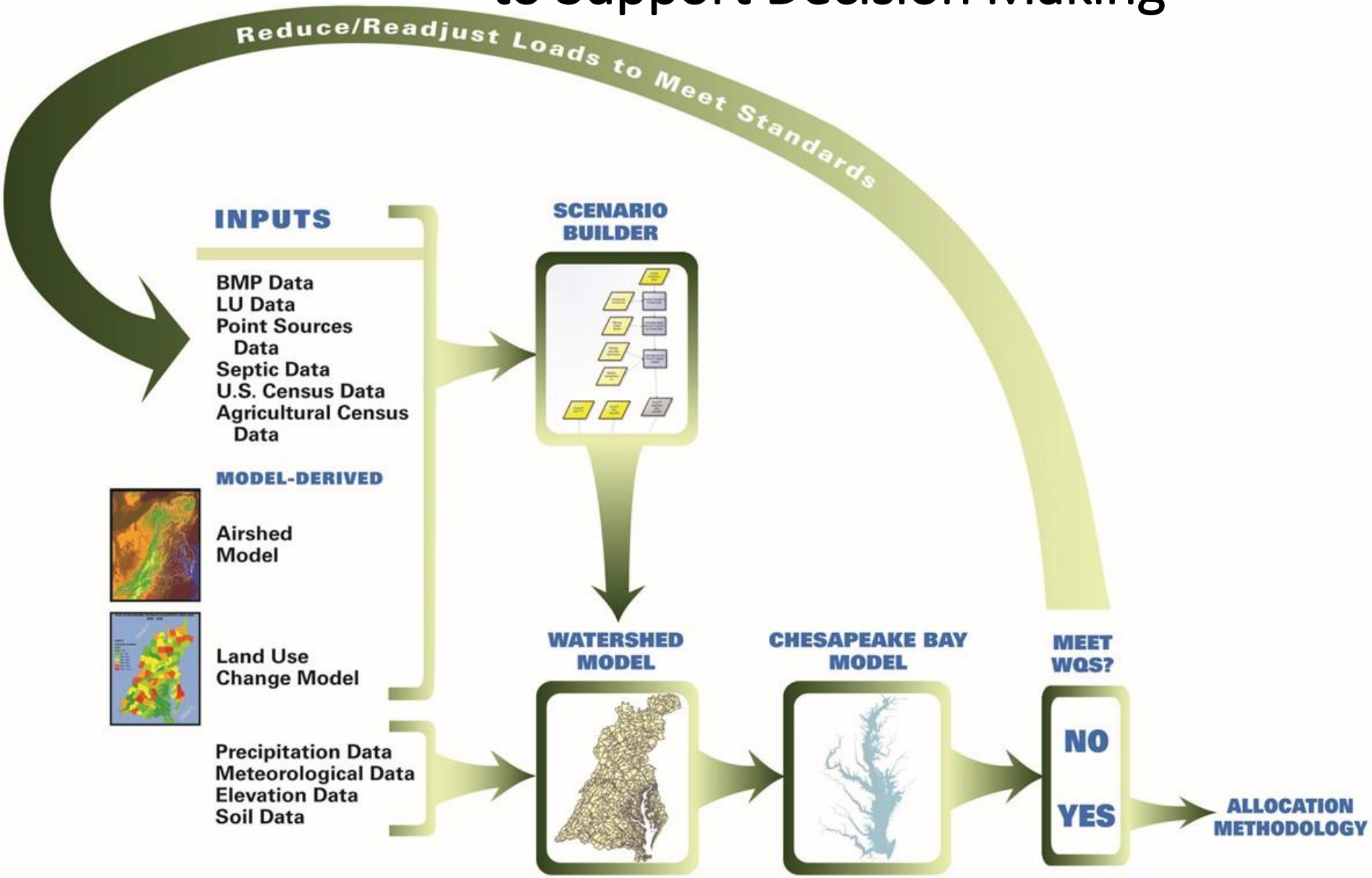
2016 Phase 6 Model Review Timeline



Reviews

- STAC Reviews
  - Scenario Builder / Nutrient Inputs (summer)
  - Watershed Model (fall)
  - Estuarine WQSTM (winter)
- Partnership Review
  - Started with 2012 WQGIT F2F and BBBM workshop
  - Continual work in MWG, WQGIT, and all WQGIT WGs
  - Prototypes and Beta versions
  - Beta 4 will have all changes except for land use
  - Final model review April – May 2017
  - WQSTM being reviewed by MWG during this period

Chesapeake Bay Partnership Models to Support Decision Making







Phase 6 Model Structure

Average Load + ΔInputs * Sensitivity

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Land Use Acres

*

BMPs

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Land to Water

*

Stream Delivery

*

River Delivery

Direct Loads

Phase 6

Multiple models

Multiple Lines of Evidence And multiple models

Average Load = Δ Inputs * Sensitivity

*

Land Use Acres

*

BMPs

Scenario Builder

*

Estimated with Sparrow
Estimated by Land Data team

Land to Water

Estimated with Sparrow
Estimated by USGS / WVU / land data team

*

Stream Delivery

*

River Delivery

Simulated in HSPF
Calibrated with data, WRTDS, and Sparrow

Setting

Calculation

Science Quality

Delivered Load from a land use =

Avg No BMP Nutrient Load

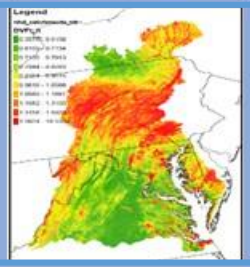
+

Sensitivity * Change in Inputs

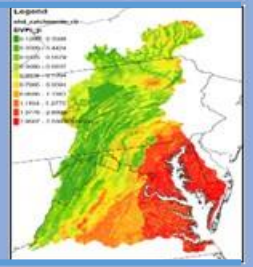
*****

Land to water

SPARROW
For nitrogen:
Soil, vegetation,
and climate variables



SPARROW
For Phosphorus
Soil, slope,
and climate
variables



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BMPs

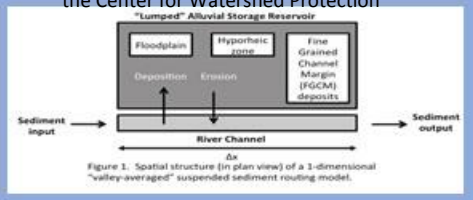
Effect of BMPs

*****

Stream Delivery

Sparrow

Potential models from USGS and
the Center for Watershed Protection



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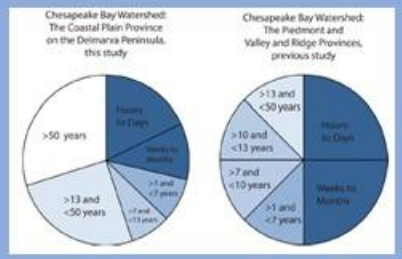
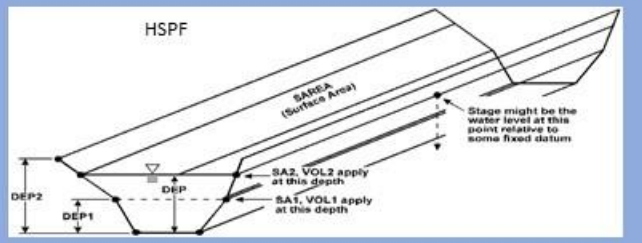
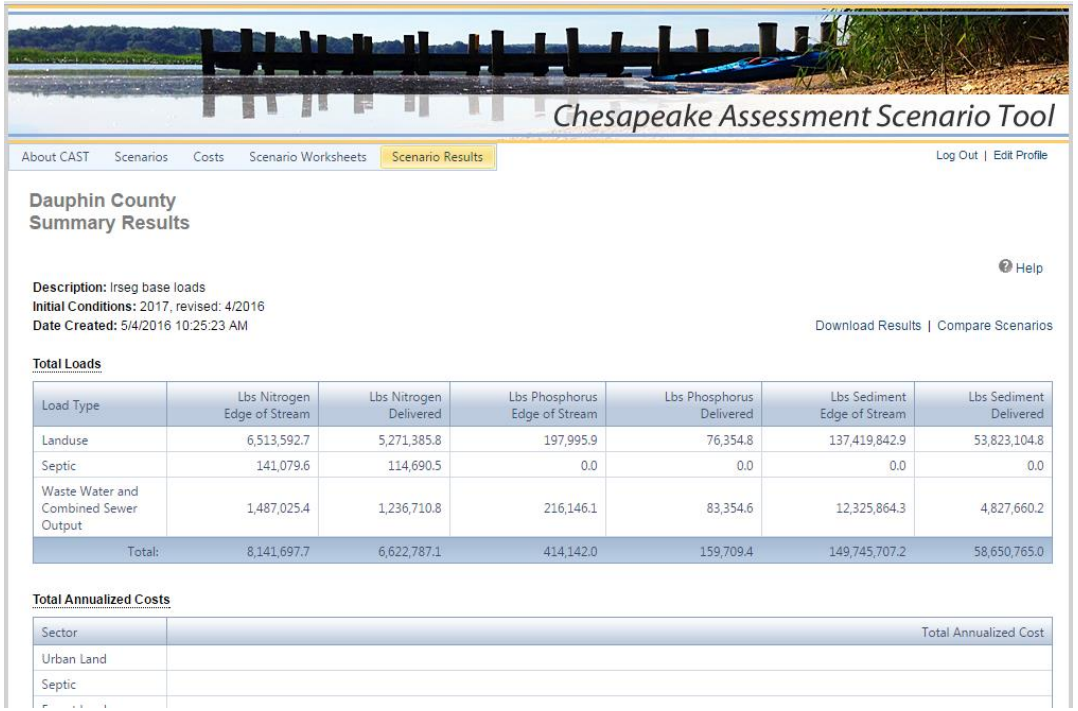
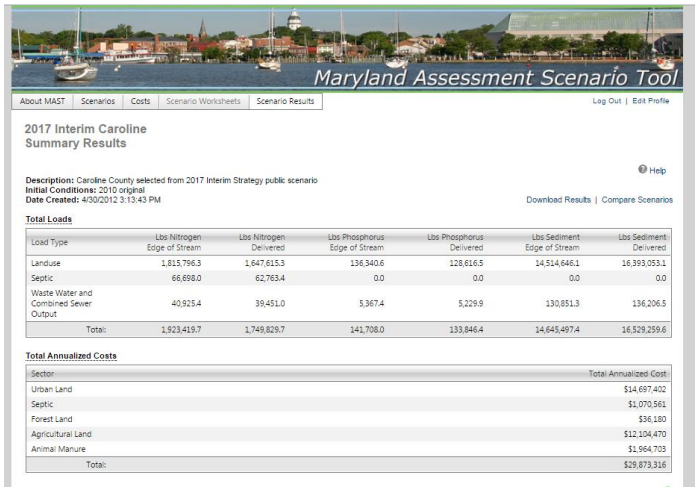
River Delivery

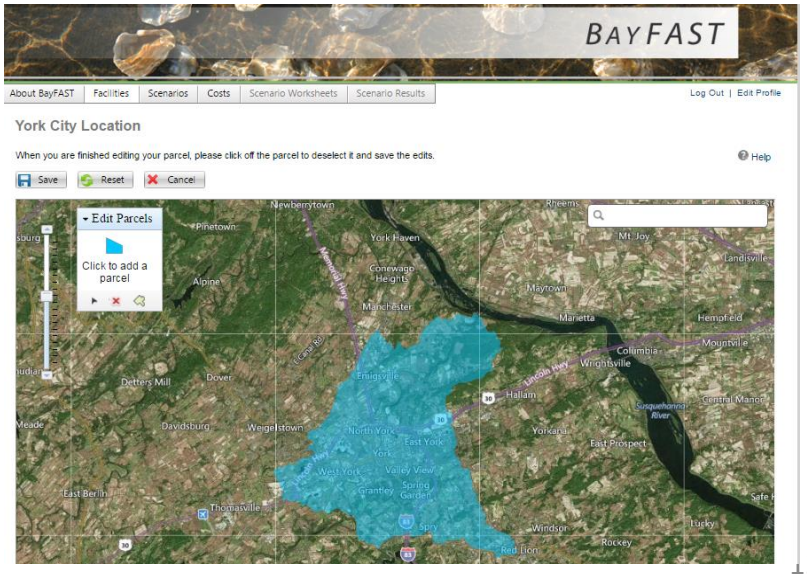




On-Line Tools



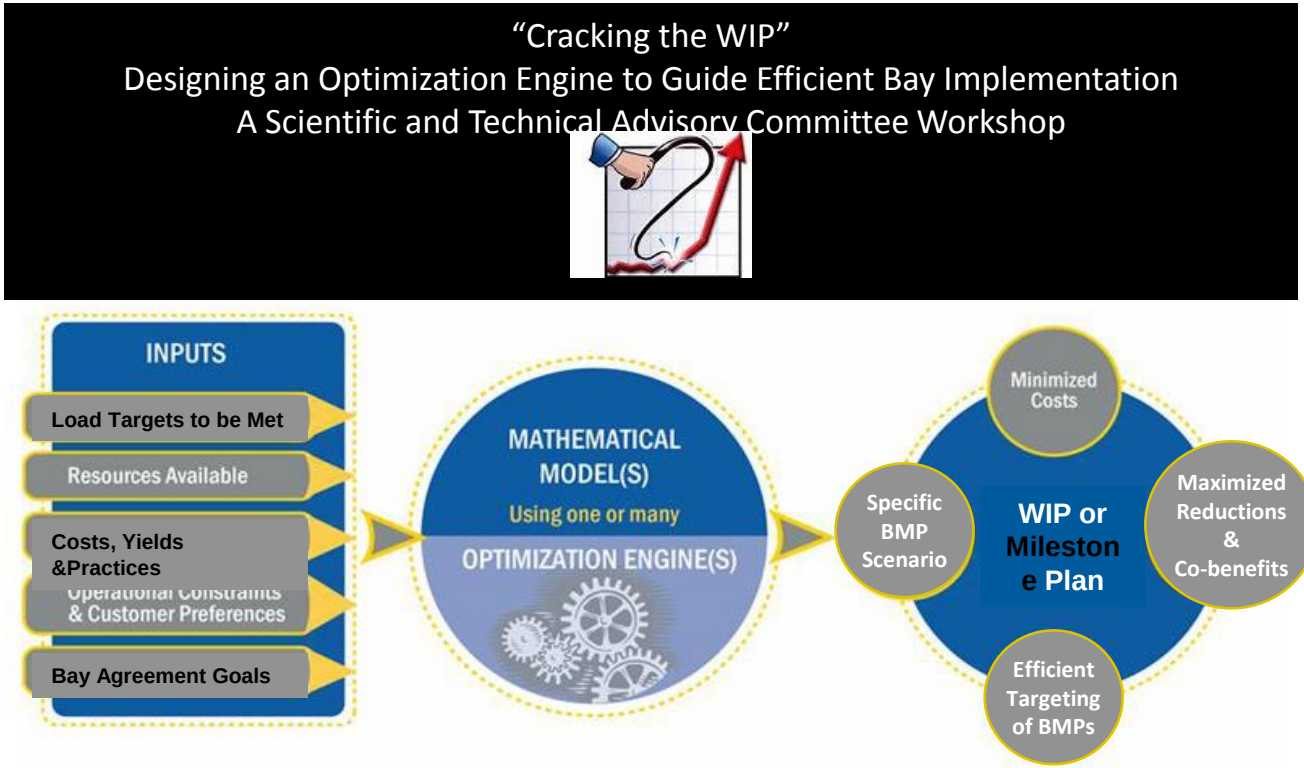




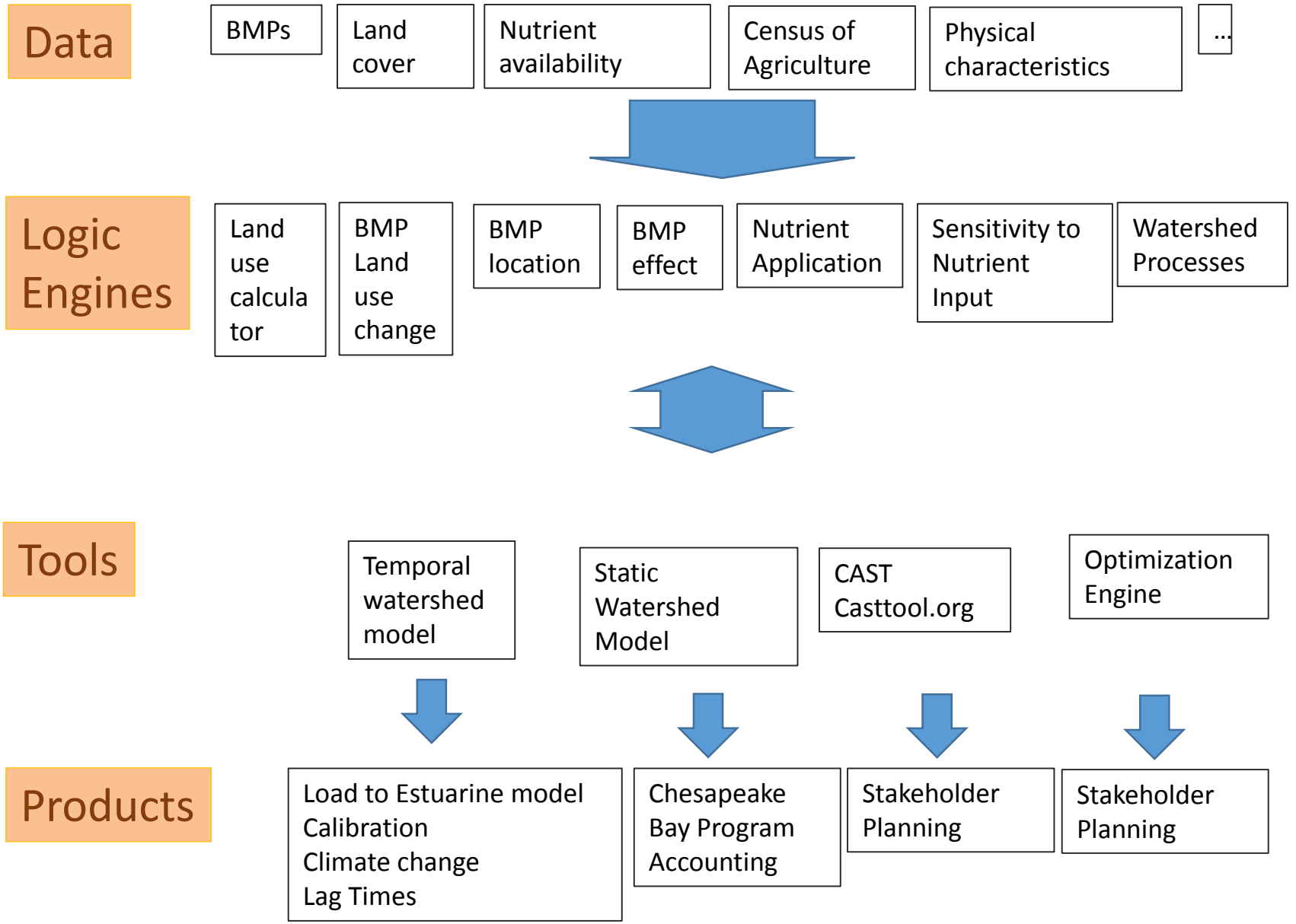
Slide from Olivia Devereux

OPTIMIZATION Calculation Engine

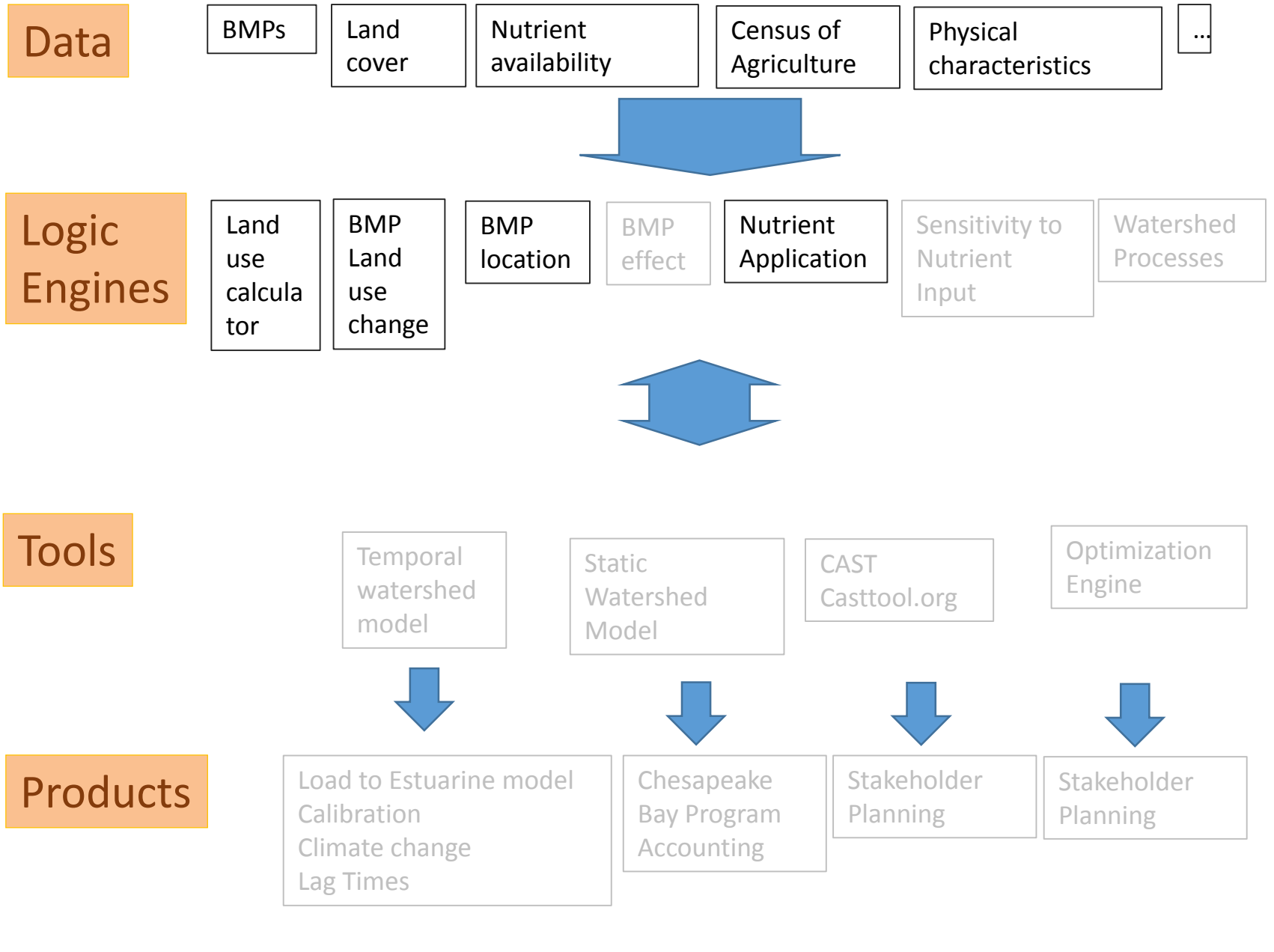
Users input objectives, tool outputs BMPs in the plan that maximize effectiveness at minimum cost.



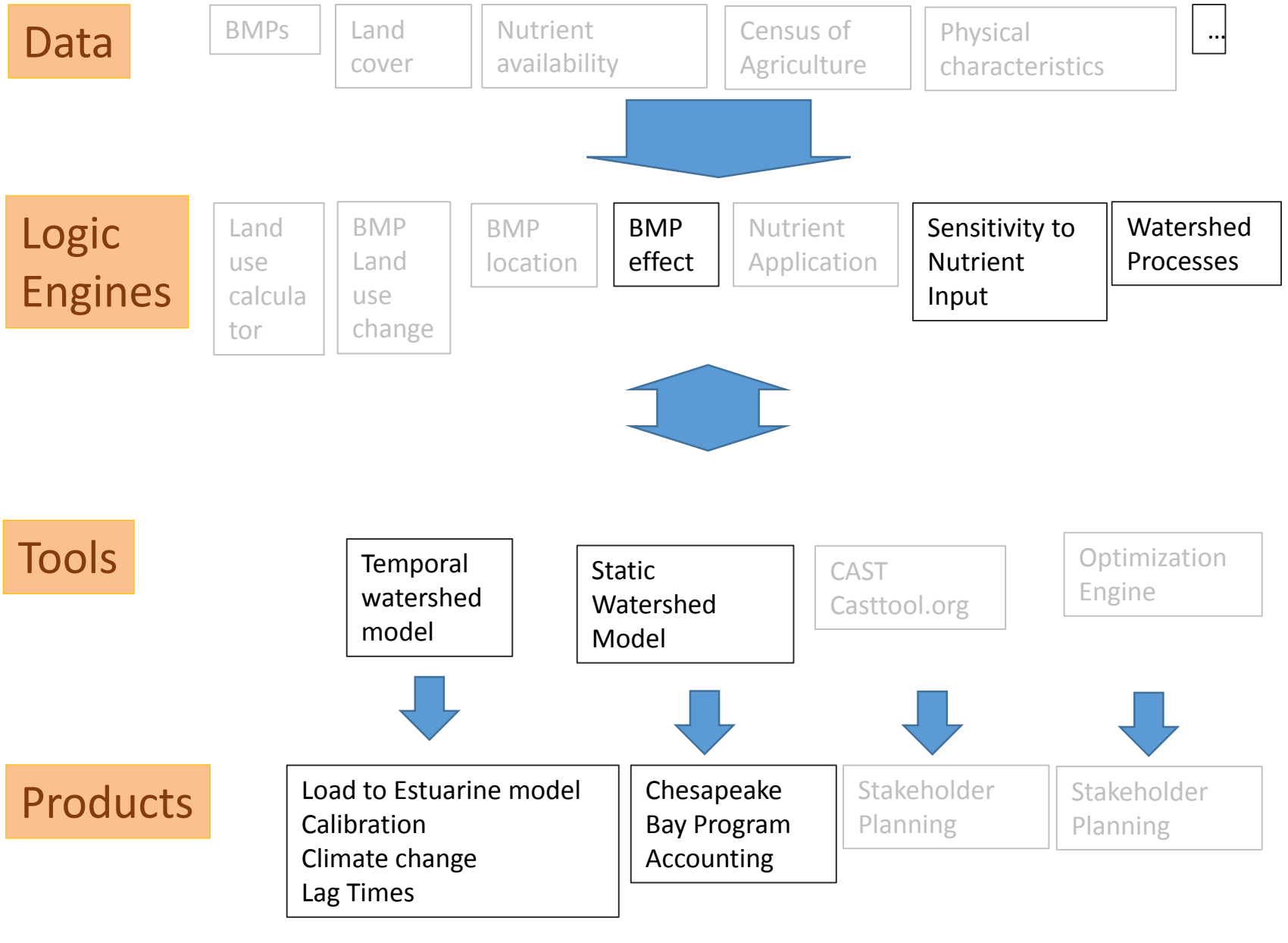
CBP Watershed Simulation



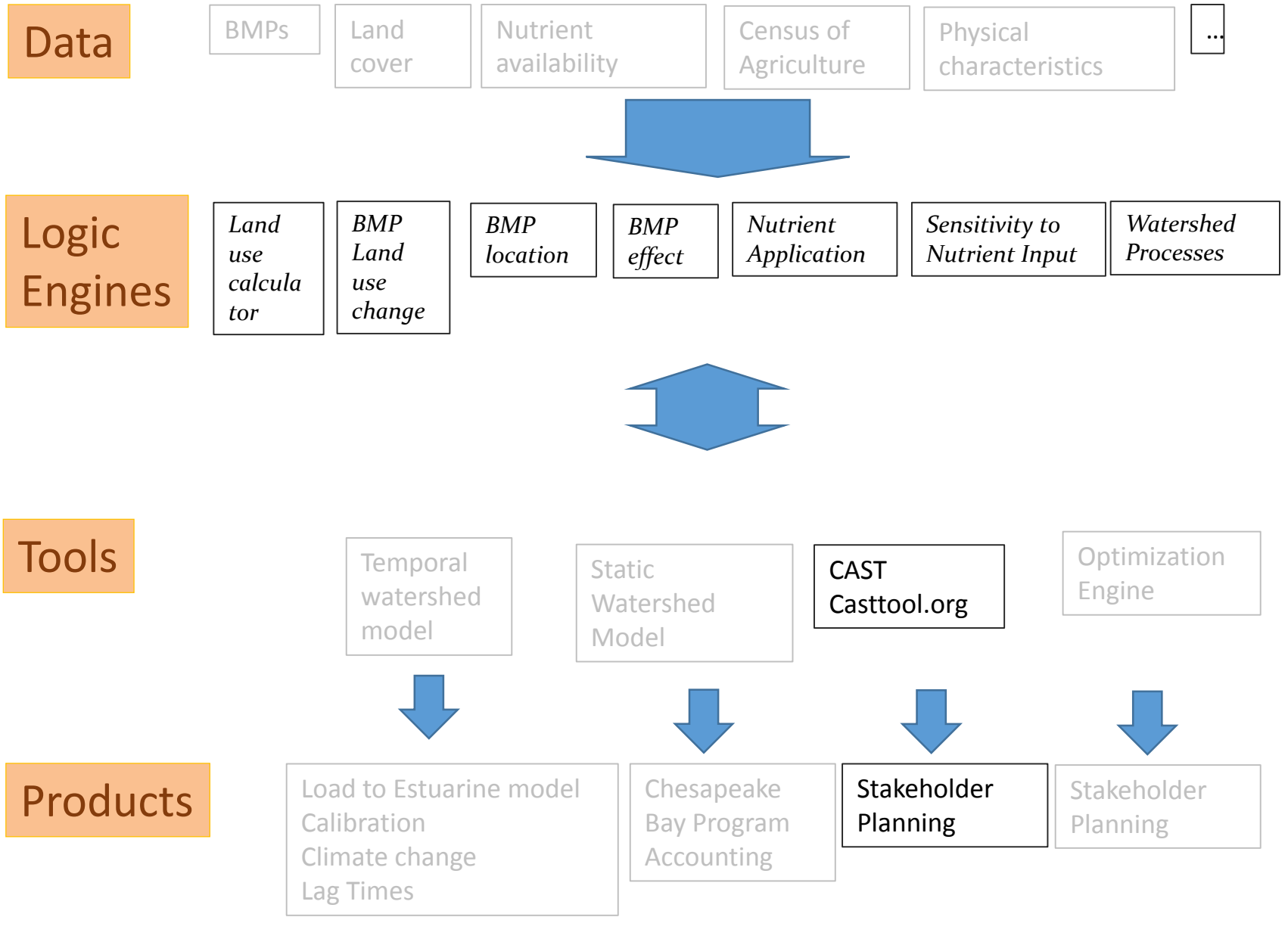
‘ Phase 5 Scenario Builder’



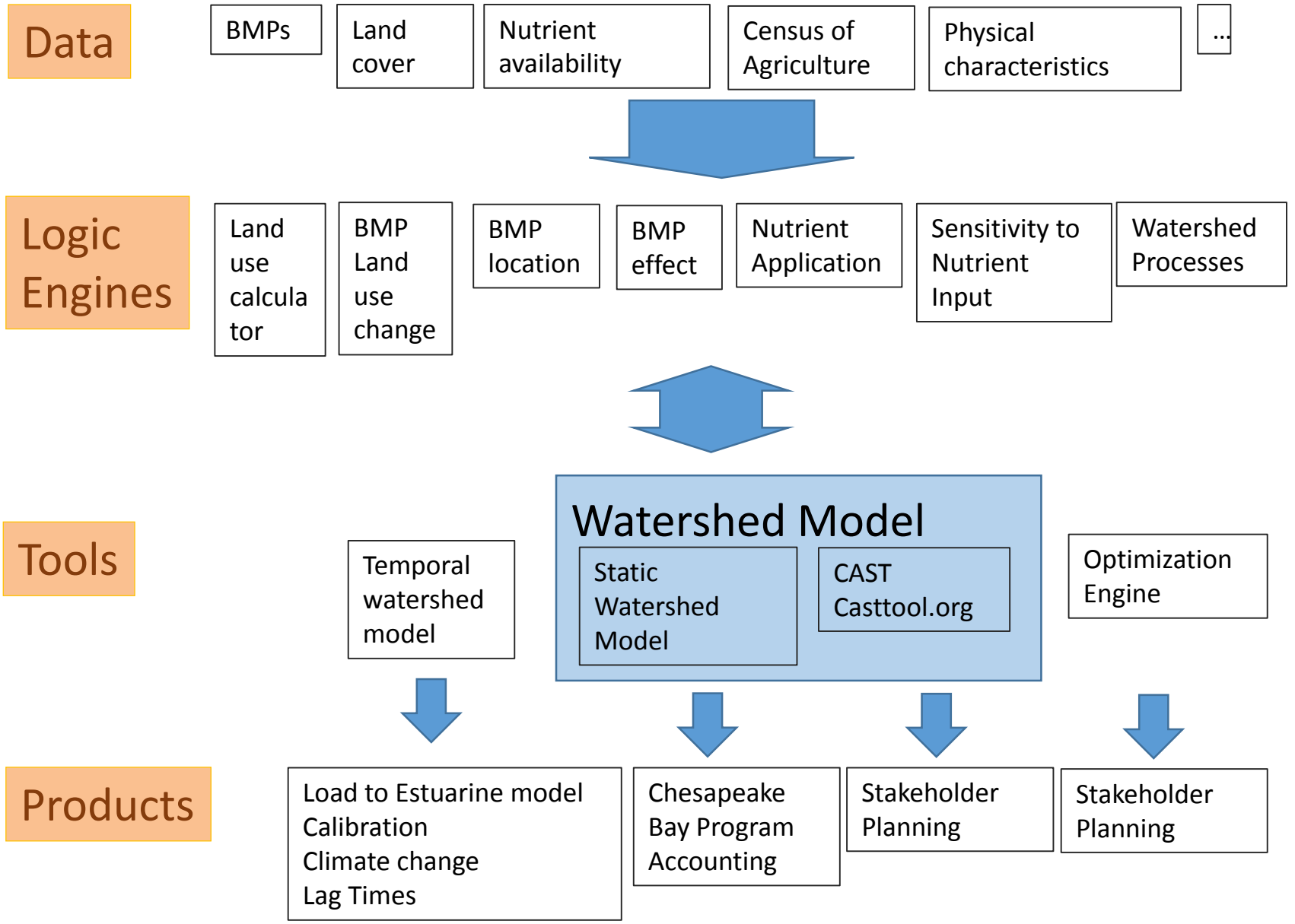
‘ Phase 5 Watershed Model’



‘Phase 5 CAST’


Data
BMPs
Land cover
Nutrient availability
Census of Agriculture
Physical characteristics
...
Logic Engines
Land use calculator
BMP Land use change
BMP location
BMP effect
Nutrient Application
Sensitivity to Nutrient Input
Watershed Processes
Tools
Temporal watershed model
Static Watershed Model
CAST Casttool.org
Optimization Engine
Products
Load to Estuarine model
Calibration
Climate change
Lag Times
Chesapeake Bay Program Accounting
Stakeholder Planning
Stakeholder Planning

CAST = WSM = Scenario Builder







Phase 6 Model Structure

Average Load + Δ Inputs * Sensitivity

*

Land Use Acres

*

BMPs

*

Land to Water

*

Stream Delivery

*

River Delivery

Direct Loads

Phase 6





Phase 6 Model Documentation

Section 2: Average Loads + Section 3: Inputs * Section 4: Sensitivity

*

Section 1: Overview

Section 5: Land Use

*

Section 6: BMPs

*

Section 8: Direct Loads

Section 7: Land to Water

*

Section 9: Stream Delivery

*

Section 10: River Delivery

Section 11: Applications





Phase 6 Model Documentation

Section 2: Ave Load 27 pages + Section 3: Inputs 48 pages * Section 4: Sensitivity 19 pages

Section 5: Land Use – 12 pages

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Section 6: BMPs – 12 pages

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Section 7: Land to Water – 22 pages

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Section 9: Stream Delivery – 25 pages

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Section 10: River Delivery – 88 pages

Section 1: Overview 13 pages

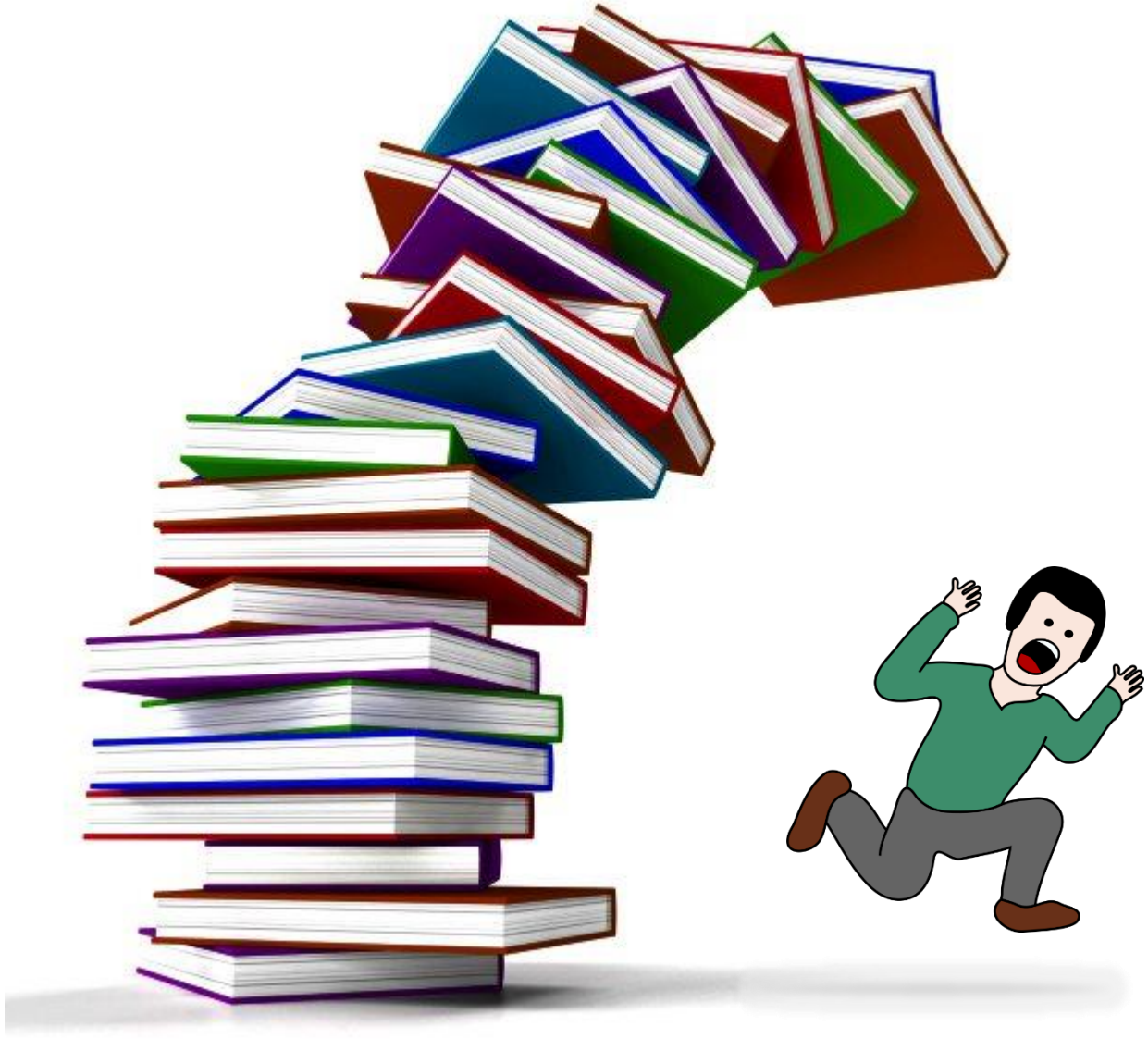
Section 8: Direct Loads – 4 pages

Section 11: Applications 0 pages

Section 12: References – 33 pages

Total = 299 pages
+ 257 pp appendices

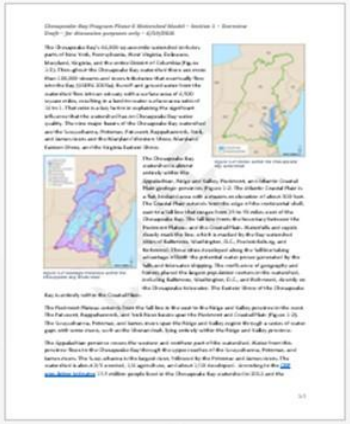
Review Strategy

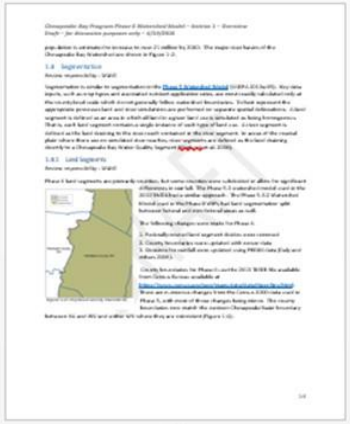


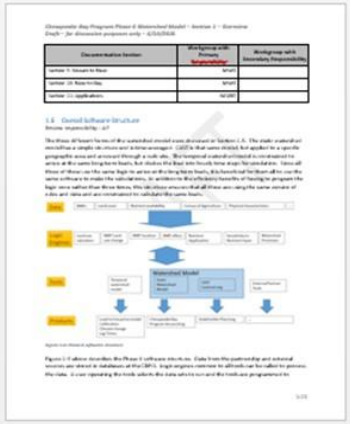
Review Strategy

- Read Chapter 1
- Target Chapters and Sections that are important to you

- Main Prediction of CAST for decision support:
  Change in Anthropogenic Load
  - BMPs
  - WWTP
  - Land use Change
  - Response to Change in inputs





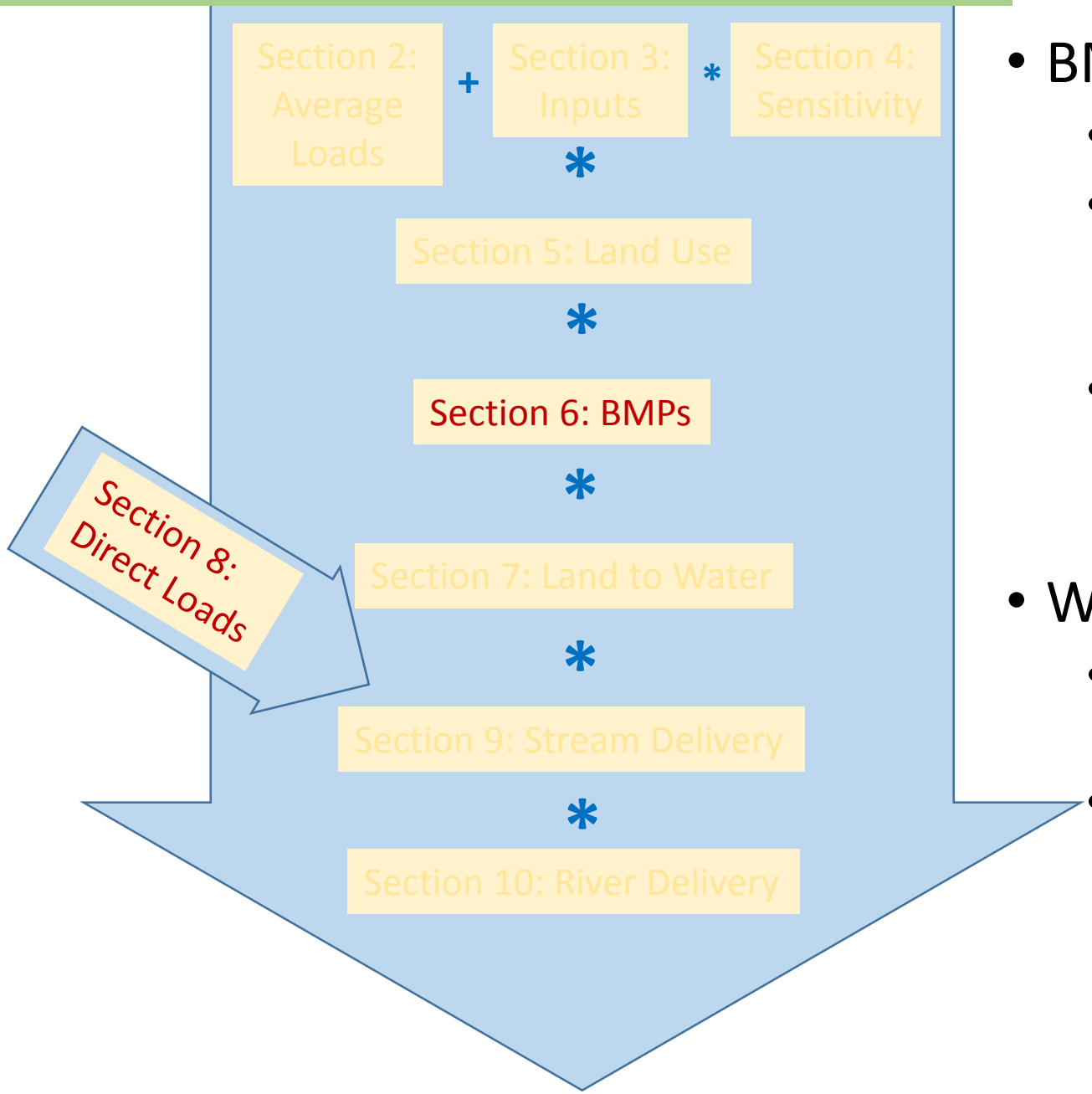


Review Strategy

- Read Chapter 1
- Target Chapters and Sections that are important to you. – or – talk to someone on the relevant workgroup

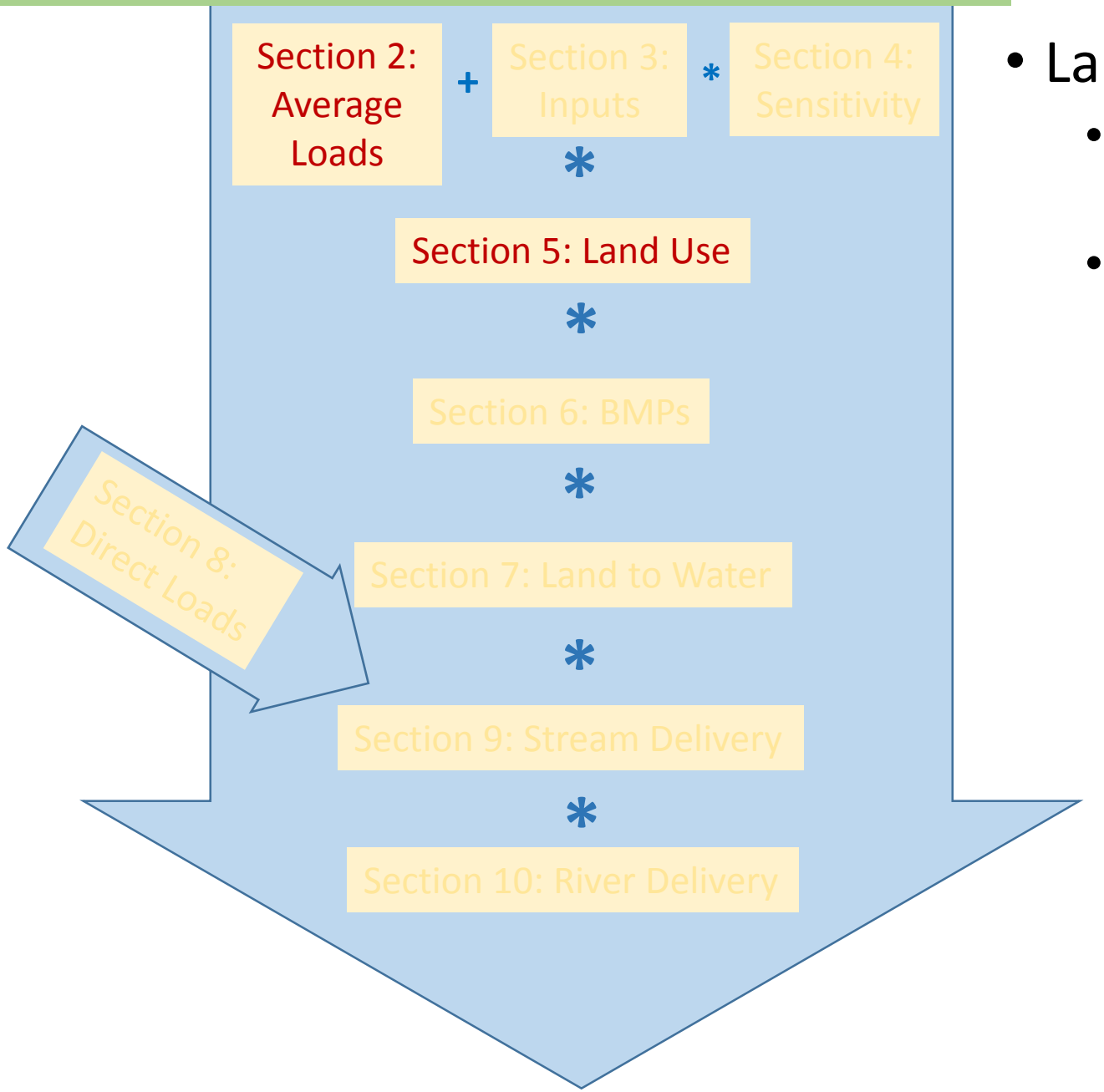
- Main Prediction of the Watershed Model for decision support: Change in Anthropogenic Load
  - BMPs
  - WWTP
  - Land use Change
  - Response to Change in inputs

Phase 6 Model Documentation



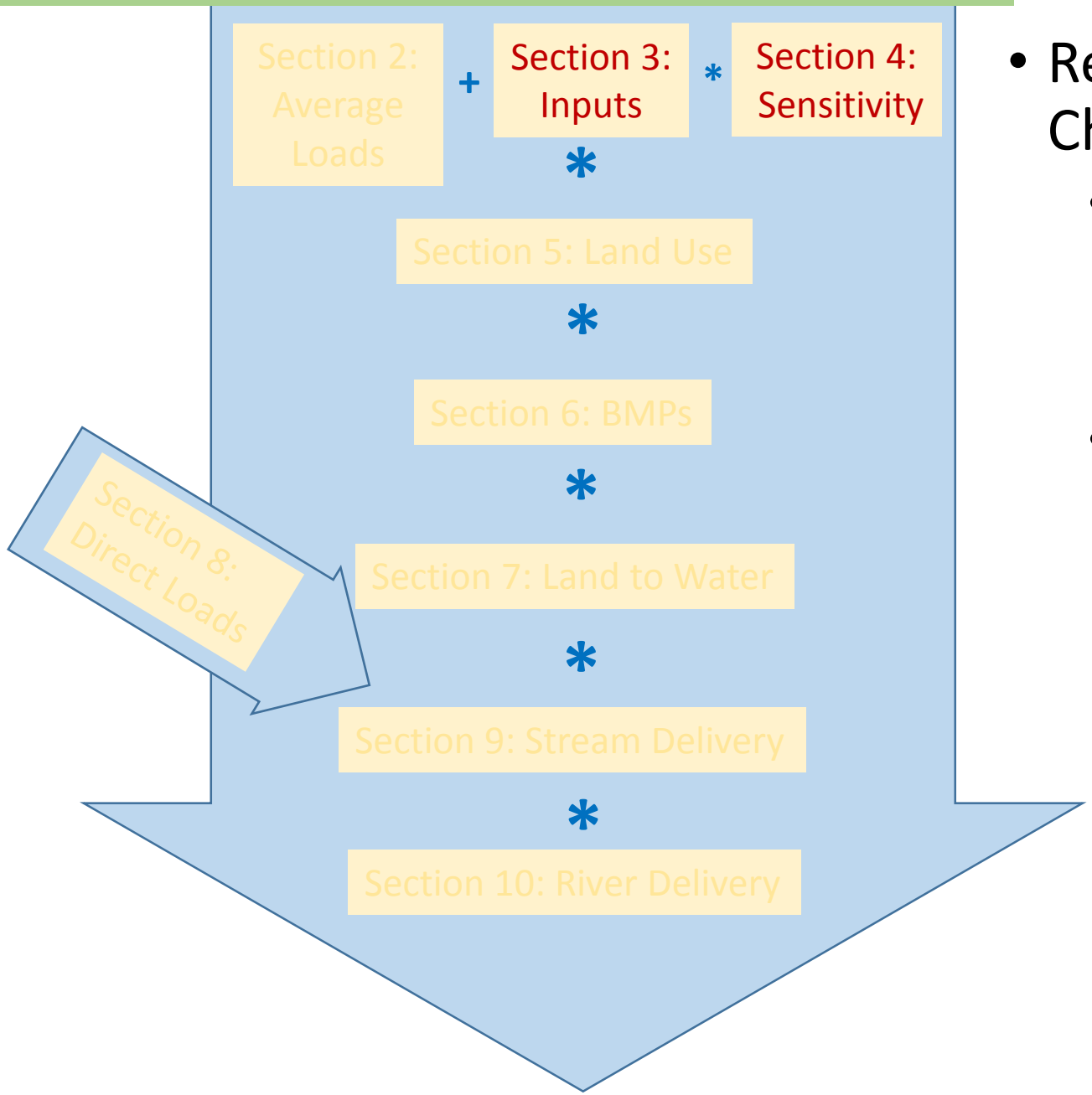
- BMPs
  - Section 6 BMPs
  - Separate review process for effectiveness
  - Can review application method
- WWTP
  - Section 8 Direct Loads
  - Submitted Data

Phase 6 Model Documentation



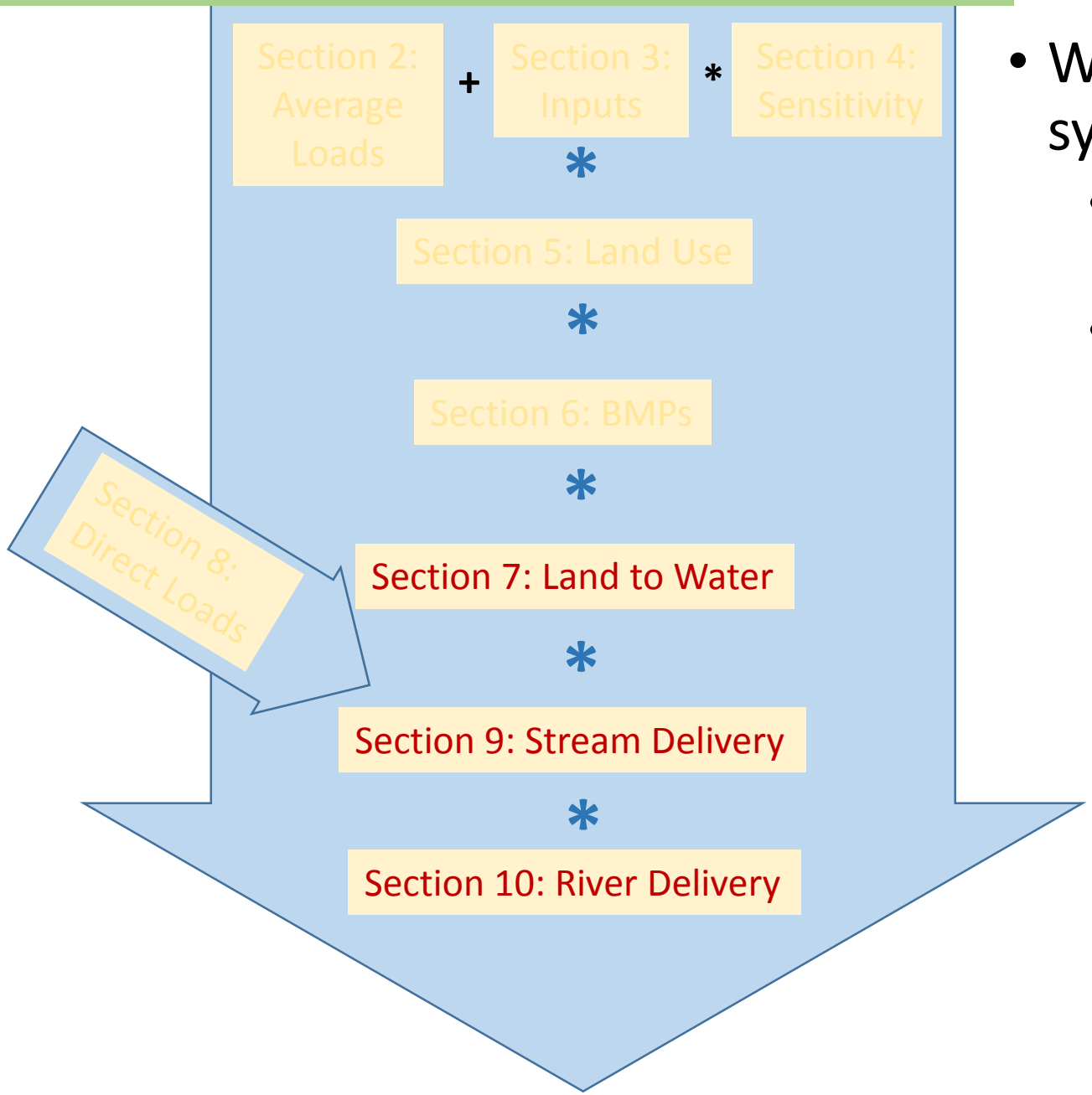
- Land use Change
  - Section 5 Land use
    - Not final
  - Section 2 Average Loads
    - Modeling workgroup
    - WQGIT workgroups

Phase 6 Model Documentation



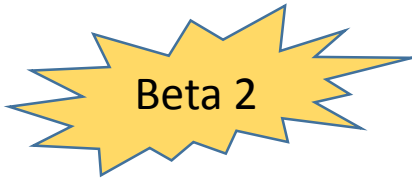
- Response to Change in Input
  - Section 3 Inputs
    - 'scenario builder'
    - WQGIT workgroups
  - Section 4 Sensitivity
    - Modeling workgroup

Phase 6 Model Documentation



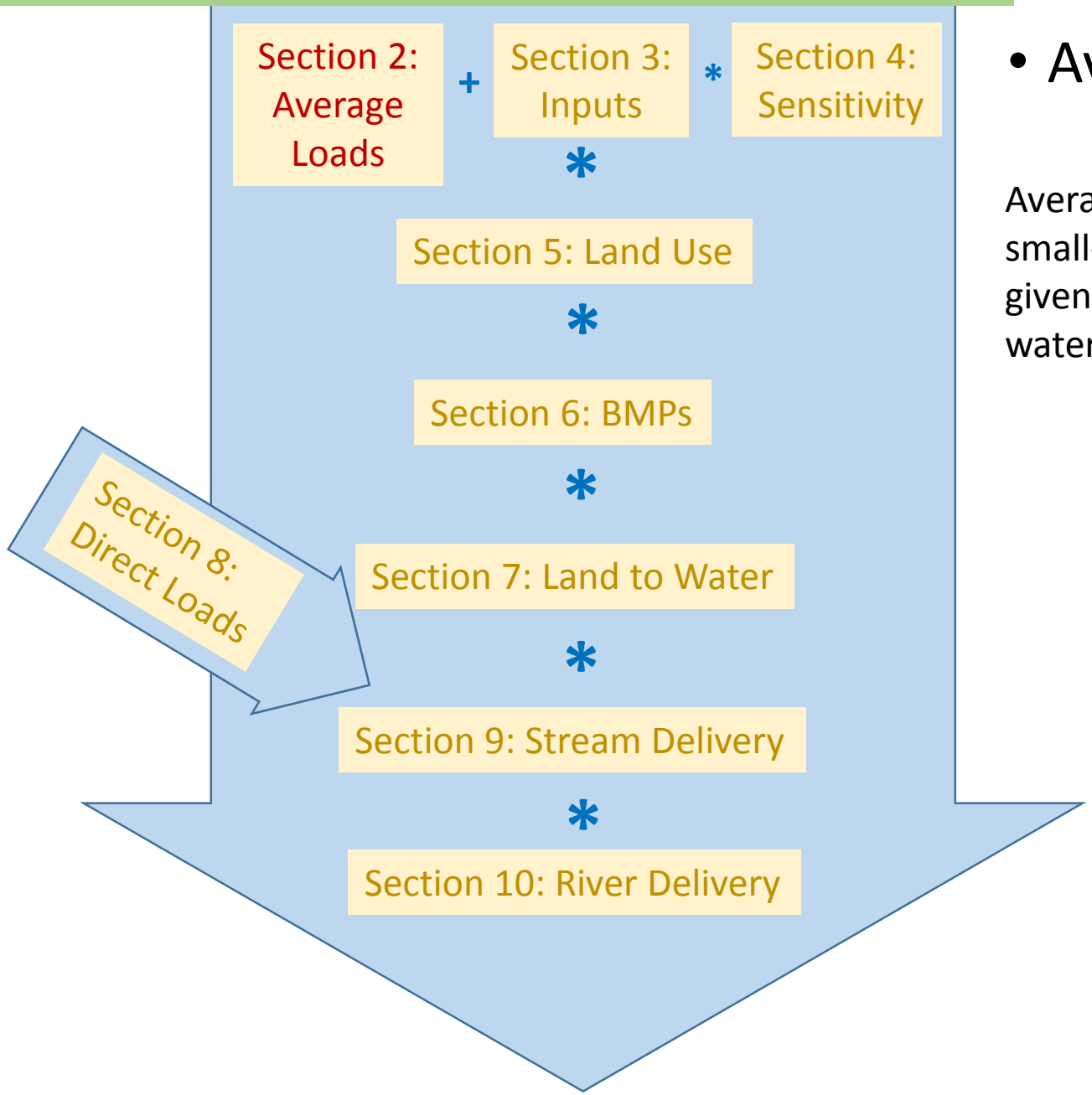
- Watershed Delivery system
  - Spatially distribute loads
  - Check for agreement with monitoring data
    - Modeling workgroup

Major refinements Beta 1 => Beta 2



- Extreme flow events
- Sediment overhaul
- Updated physical watershed data
  - Land to water
  - Stream to river
  - Small reservoirs
  - Groundwater nitrate lag
- Updated input data
  - Point source correction
  - Monitoring data

Phase 6 Model Documentation



- Average Loads

Average Loads – Average edge-of-small-stream loading rate for a given land use for the entire CB watershed

Beta 2

Average Loads

Average Loads – Average edge-of-small-stream loading rate for a given land use for the entire CB watershed

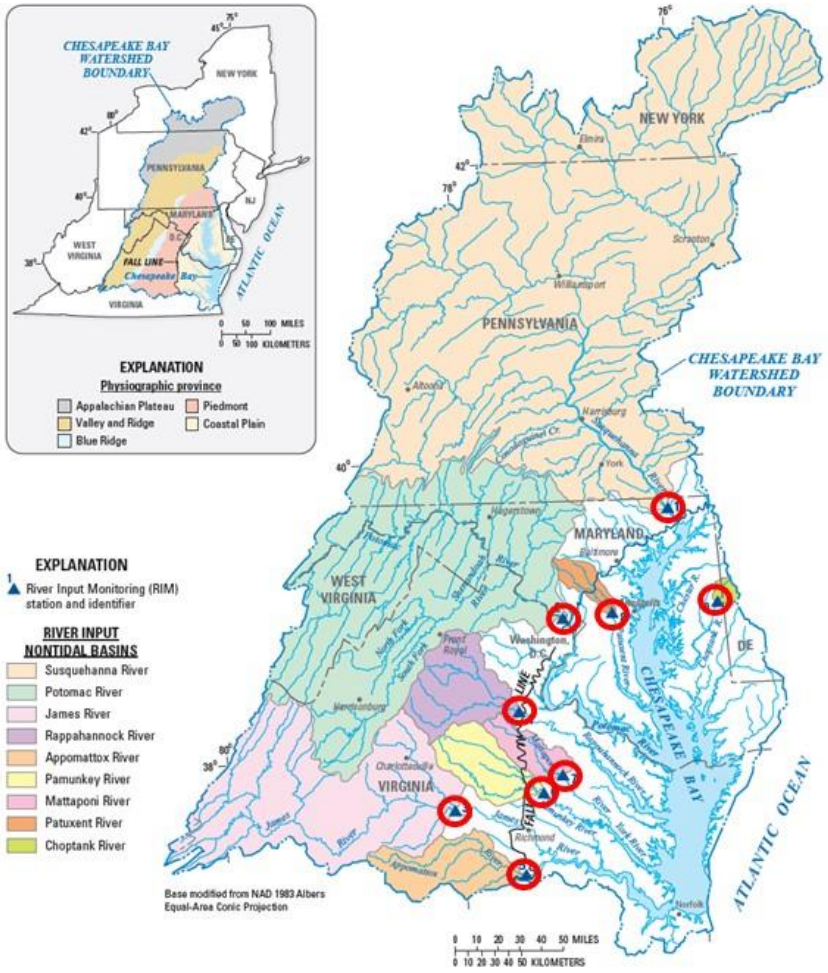
Estimate Total Non-point Source

Modeling Workgroup

Monitoring Data

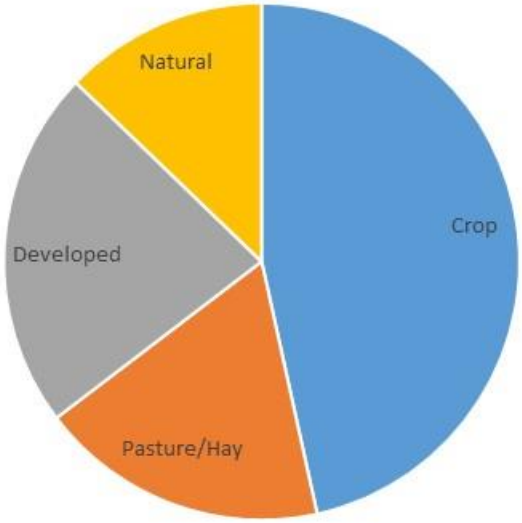
subtract point source

divide by river transport



Average Loads

Average Loads – Average edge-of-small-stream loading rate for a given land use for the entire CB watershed



Divide into Broad Classes

Modeling Workgroup

Multiple models

Phase 5.3.2

Sparrow

CEAP

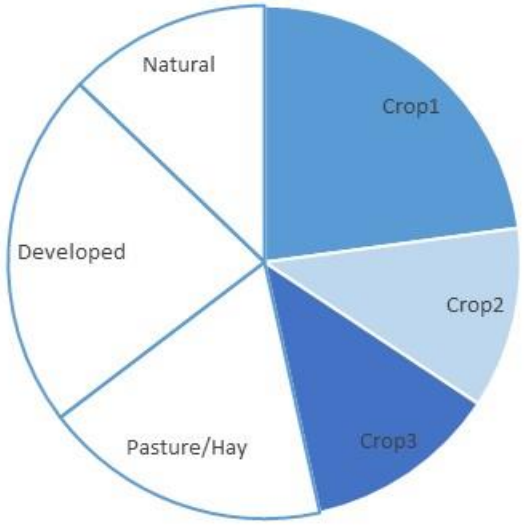
Divide into broad classes -- Nitrogen

Sector	Crop	Pasture/ Hay	Developed	Natural
Acres*	4,361,964	5,156,450	5,289,606	24,788,695
P532 Export Rate (pounds per acre)	47.5	19.9	19.4	4.2
CEAP Export Rate (pounds per acre)	42.5	10.2	Not used	1.6
SPARROW Export Rate with BMP effects removed (pounds per acre)	22.9	10.2	8.9	0.4
Average Ratio to Crop Rate	1.00	0.37	0.40	0.05
Average Sector Export Rate (pounds per acre)	46.65	15.36†	18.62	2.26

** Note that no target is calculated for 1,148,100 acres in the land uses: permitted feeding space, non-permitted feeding space, and combined sanitary sewer and water.*
† The afo/cfo load of 9,063,059 pounds is removed from pasture.

Average Loads

Average Loads – Average edge-of-small-stream loading rate for a given land use for the entire CB watershed



Split Classes into individual land uses

WQGIT Workgroups

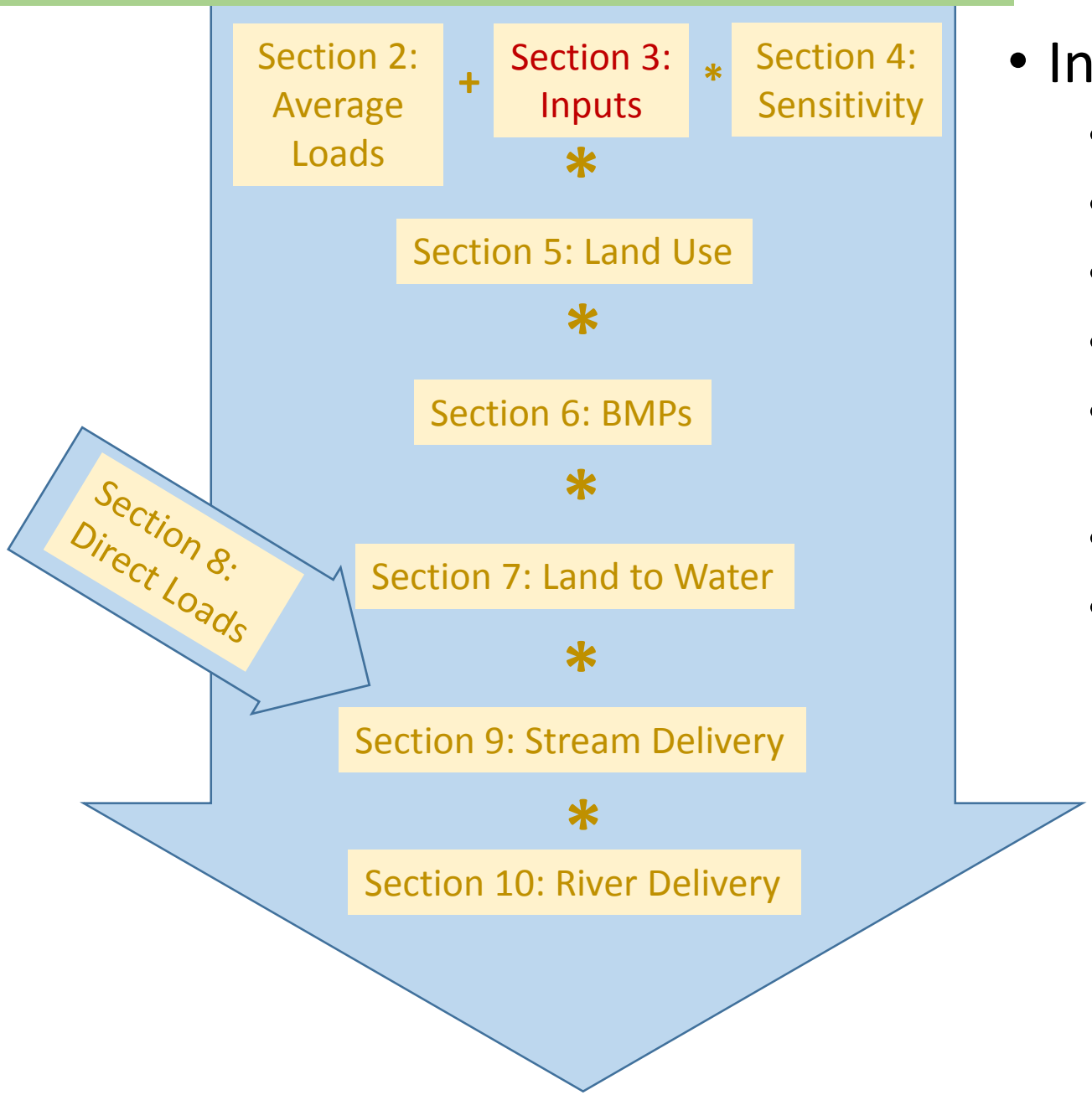
Multiple lines of evidence to develop ratios

- for example silage is 16% higher than grain

Split classes into individual land uses – Crop Nitrogen

Target Sector	Land Use	Acres	TN Export Rate Ratio	TN Export Rate (pounds per acre per year)
Cropland	Full Season Soybeans	926,048	0.71	36.98
	Grain with Manure	362,887	1.40	72.93
	Grain without Manure	989,101	1.00	52.09
	Other Agronomic Crops	527,481	0.45	23.44
	Silage with Manure	188,744	1.62	84.39
	Silage without Manure	403,534	1.16	60.42
	Small Grains and Grains	420,426	0.84	43.76
	Small Grains and Soybeans	313,019	0.79	41.15
	Specialty Crop High	66,706	1.34	69.8
	Specialty Crop Low	164,013	0.31	16.15

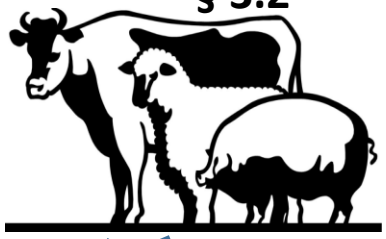
Phase 6 Model Documentation



- Inputs
  - Manure
  - Inorganic fertilizer
  - Legume fixation
  - Uptake
  - Atmospheric deposition
  - Crop cover
  - Plowing effects

Phase 6 Inputs Conceptual Model

Livestock Manure (and Biosolids)
§ 3.2

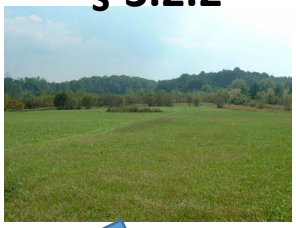


Barnyard
§ 3.2.2 and § 3.2.3

Fertilizer
§ 3.3

Nutrient Application Prescription
§ 3.2.7 and § 3.3.3

Pasture
§ 3.2.2



Access Area
§ 3.2.2

River

Crops

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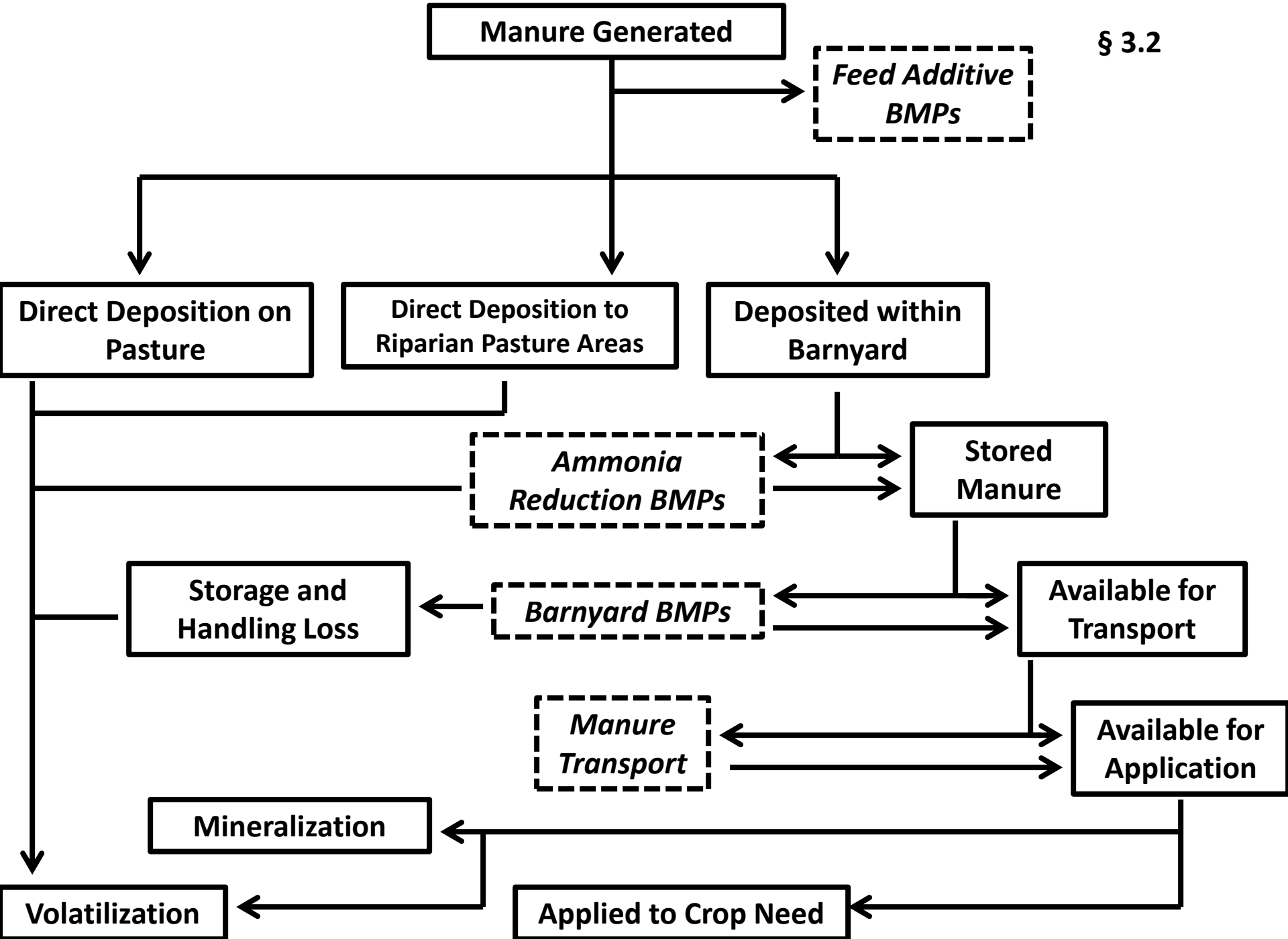
https://utextension.tennessee.edu/lincoln/4-H/Pages/Livestock-Skillathons-%28Beef,-Sheep-and-Swine%29.aspx
Rebelwoodsranch.com
Seaburst.com
http://pubs.ext.vt.edu/442/442-308/442-308.html
http://nh.water.usgs.gov/project/champlain_bmp/ag.htm


§ 3.2
Manure Generated
Feed Additive BMPs
Direct Deposition on Pasture
Direct Deposition to Riparian Pasture Areas
Deposited within Barnyard
Ammonia Reduction BMPs
Stored Manure
Storage and Handling Loss
Barnyard BMPs
Available for Transport
Manure Transport
Available for Application
Mineralization
Volatilization
Applied to Crop Need

Manure: Estimating Manure Generation § 3.2.1

Animal Type	Manure Source	Lbs Dry Manure/Animal/Yr	Lbs TN/Lb Dry Manure	LbsTP/Lb Dry Manure
Beef	Use Beef - Cow (confinement) from ASAE 2005 for manure values	5,475.00	0.028788	0.006467
Dairy	Use Lactating Cow, Dry Cow and Heifer from ASAE 2005 for manure values	4,404.33	0.042221	0.006764
Other Cattle	Use average of Beef and Dairy from above to estimate manure values	4,939.67	0.035504	0.006616
Horses	Use average of Horse- Sedentary and Horse - Intense Exercise from ASAE 2005 for manure values	3,102.50	0.031672	0.005941
Hogs for Breeding	Use Gestating Sow and Lactating Sow ASAE 2005 for manure values	657	0.070273	0.019417
Hogs for Slaughter	Use Grow-Finish from ASAE 2005 for manure values	120	0.083333	0.014167
Sheep and Lambs	Use ASAE 2003 for manure values	240.9	0.038182	0.007909
Goats	Use ASAE 2003 for manure values	680.91	0.034615	0.008462

- Poultry litter estimates vary by year and are explained in detail in the PLS report.

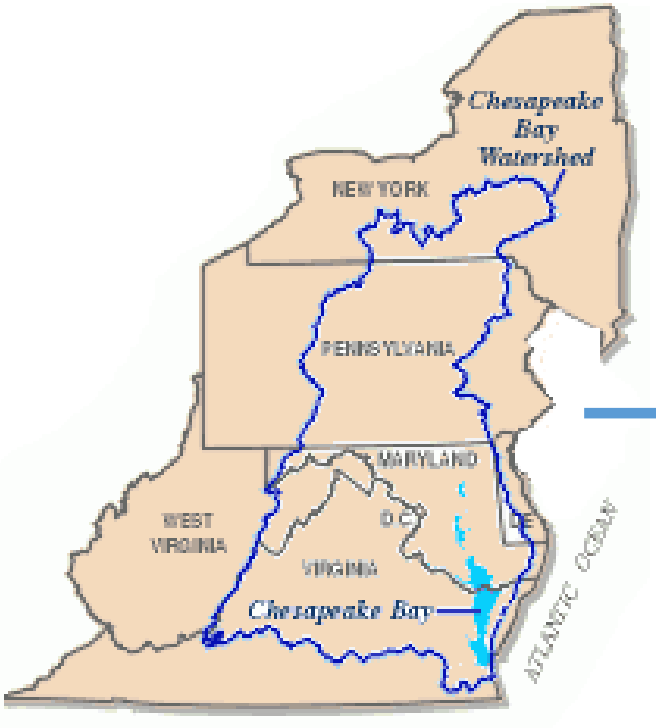
Manure: Separating Manure into Piles § 3.2.2

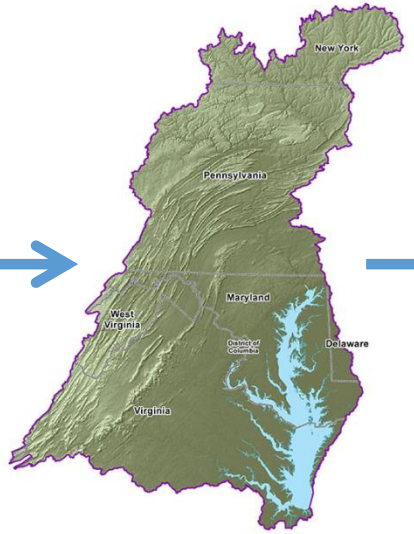
- States were asked to estimate how much time each animal type would spend in the barnyard, in pasture and in the access area.
- These percentages separate the generated manure.

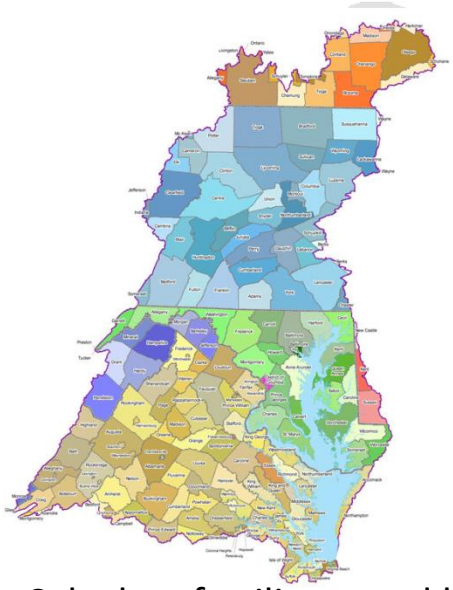
Growth Region	Animal Type	Month	Barnyard %	Pasture %	Access Area %
WV_1	beef	1	6	91	3
WV_1	beef	2	6	91	3
WV_1	beef	3	0	96	4
WV_1	beef	4	0	94	6
WV_1	beef	5	0	94	6
WV_1	beef	6	0	90	10
WV_1	beef	7	0	90	10
WV_1	beef	8	0	90	10
WV_1	beef	9	0	94	6
WV_1	beef	10	0	96	4
WV_1	beef	11	0	96	4
WV_1	beef	12	6	91	3

Inorganic: Going from Sales to Use § 3.3.1

- Begin with regional-level sales, break those down to watershed-level sales, and break those down to county-level use.







•Sum AAPFCO sales across 6 states, and estimate sales used by farms.

•Calculate dollars spent on fertilizer from Ag Census in counties inside and outside watershed to “clip” watershed-only sales.

•Calculate fertilizer need by county as a combination of fractional dollars spent on fertilizer and fertilizer need after manure is applied. Use value to distribute fertilizer to each county.

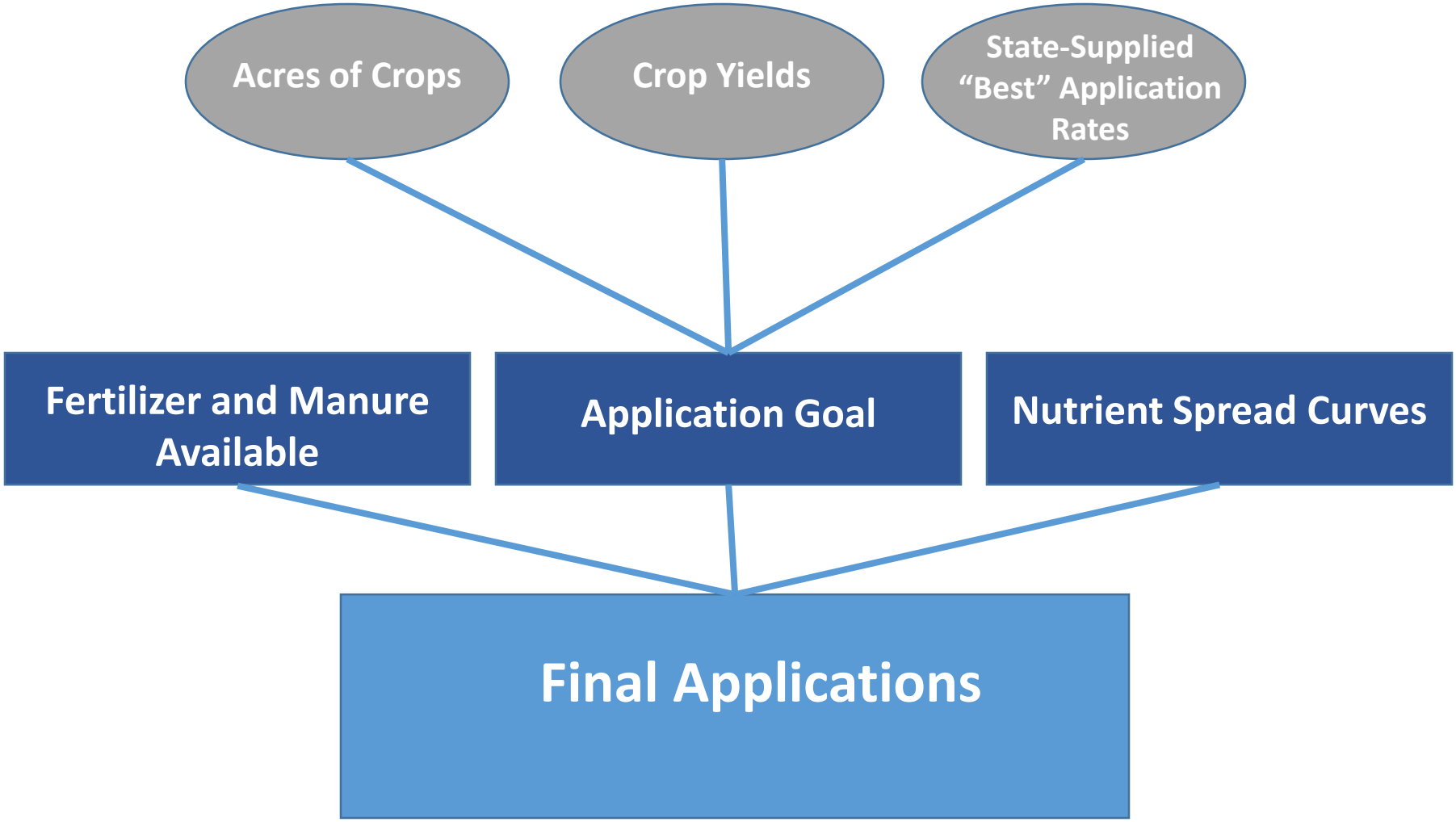
Example of Fertilizer Distribution Method for Nitrogen in 2012

- **Regional Farm Sales = 603,579,944 lbs N** or
  - *(Sum of lbs N sold across 6 states) X (3-year rolling average fraction of Farm Sales)*

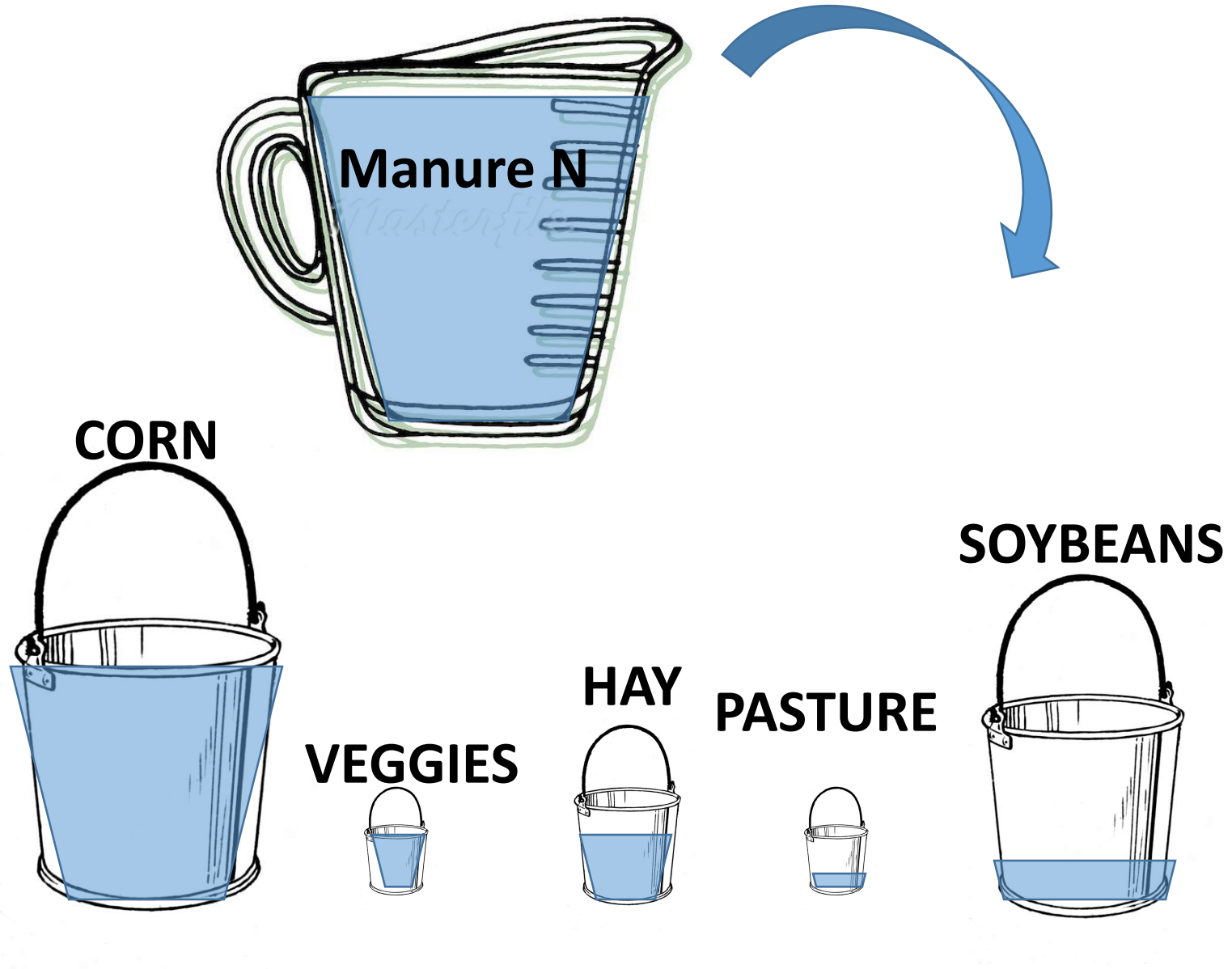
- **Watershed-Wide Farm Sales = 413,741,002 lbs N** or
  - *(Regional Farm Sales)X (Fraction of Ag Census Expenditures on Fertilizer and Soil Amendments that occurred within the Watershed)*

- **Fertilizer Available for Hypothetical County = 8,274,820 lbs N** or
  - *(Watershed-Wide Farm Sales) X [(Fraction of Ag Census Expenditures on Fertilizer within County X 0.5)+(Fraction of Fertilizer Need within County X 0.5)]*

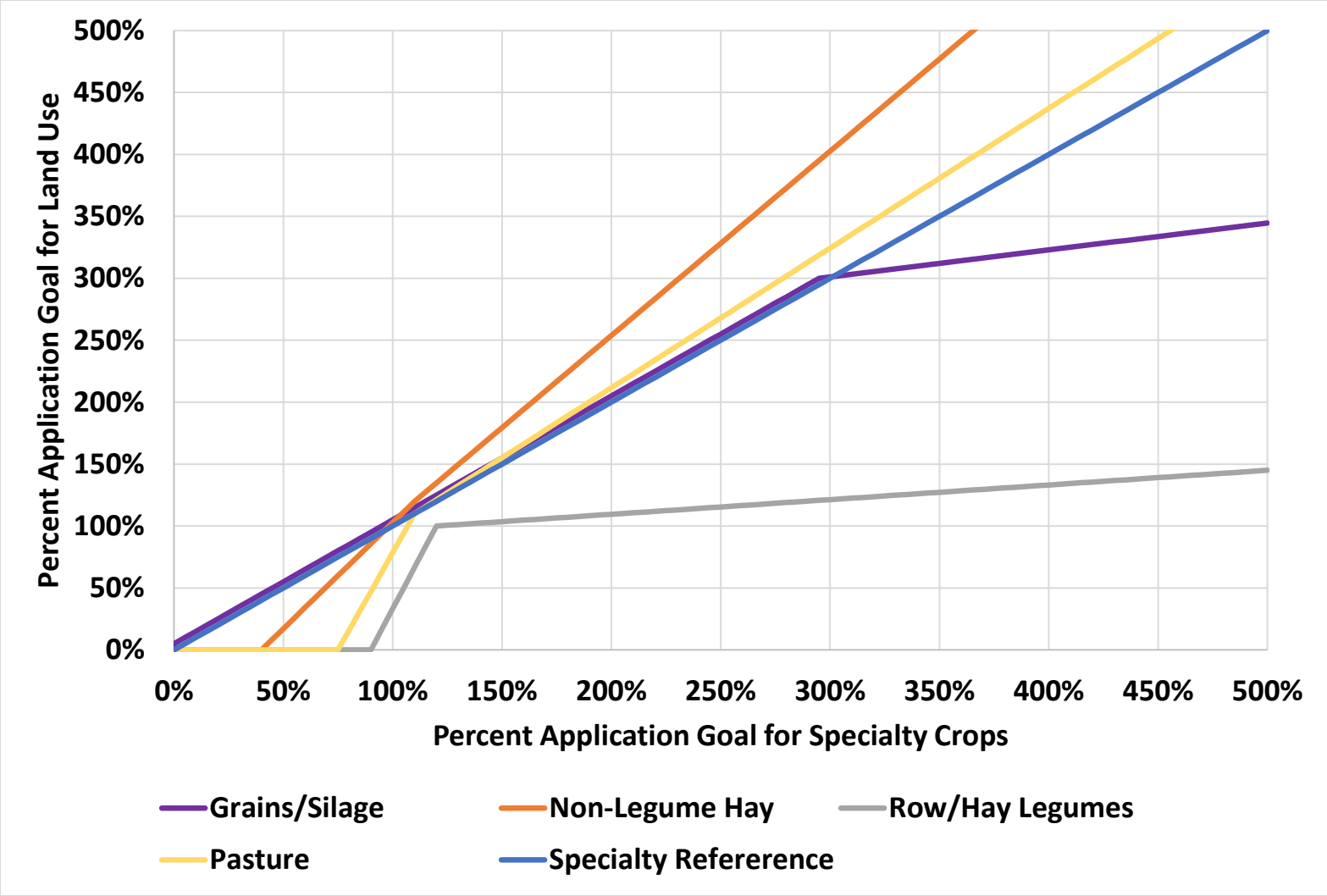
“Prescribing” Applications to Crops § 3.2.7 and § 3.3.3



Filling the Buckets of Application Goal



Manure: Prioritizing Manure Nitrogen Applications (and Biosolids) § 3.2.8



Revisions for Beta 2 (April)

Beta 2

- Improvements for April calibration include:
  - Inorganic fertilizer distributed to crops only after all BMPs are simulated.
  - Manure mineralization rates, which impact the amount of manure nutrients available to crops, updated to reflect typical nutrient management mineralization rates by decade.
  - Manure recoverability, or the amount of manure generated in a barnyard that can be made available to crops, before and after the implementation of Animal Waste Management Systems was updated to reflect estimates provided in http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_012131.pdf.
  - Acres of barnyards or feeding facilities were updated to reflect the Bay Program's best estimates per animal type.
  - Nutrient application goals for the minor crops, emmer, spelt and triticale, were based upon state-recommended applications on a per acre basis as very little yield data was available to vary the application goals by annual yield
  - New BMP information submitted by some states.
  - New biosolids data submitted by DE.

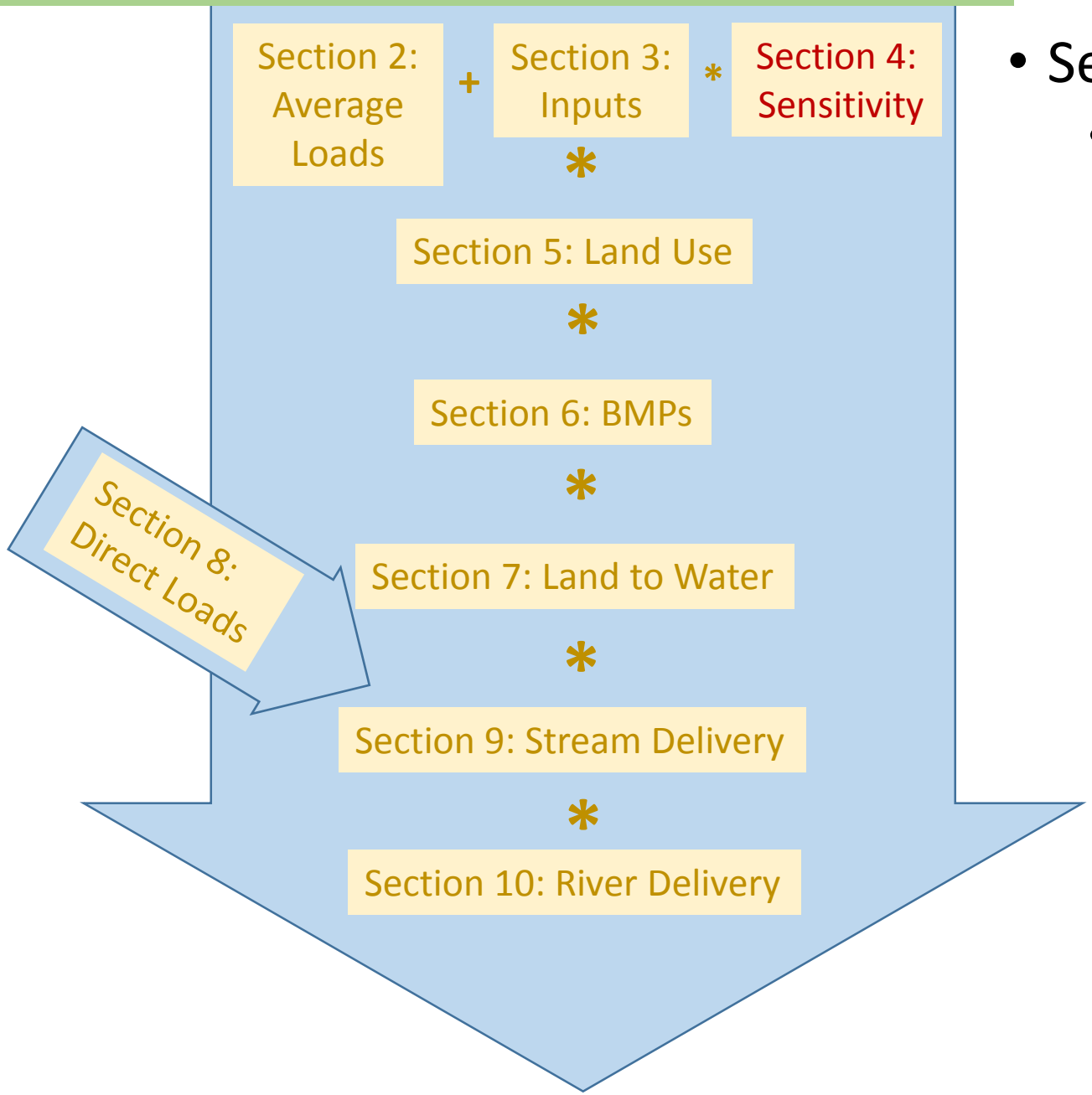
Revisions for Beta 3 (July)

- **Crop Application Goals**
  - Group of Agricultural Workgroup state representatives worked with the AMS to revise crop application goals so they better reflect land-grant university recommendations.
- **Non-Nutrient Management Application Goal Multiplier**
  - Subgroup of Nutrient Management expert panel supplied revised multipliers for Crop Application Goals.
- **Legume Fixation**
  - AMS approved use of new equation to estimate legume fixation based upon estimates of nitrogen from soils, manure and inorganic fertilizer.
- **Crop Removal**
  - AMS reviewed existing crop removal/uptake values, and agreed to adjust values for corn, beans, pasture and non-legume hay.
- **Barnyard Area for Other Cattle**
  - Area adjusted so it better reflects NRCS estimates of area used by cattle.
- **Biosolids**
  - Ag Workgroup and Wastewater Technical Workgroup approved use of new curves to spread biosolids to crops.

Atmospheric Deposition

- Currently using phase 5.3.2
- Expecting Data set from Penn State for Beta 4
- Data set will be modified by scenarios in CMAQ

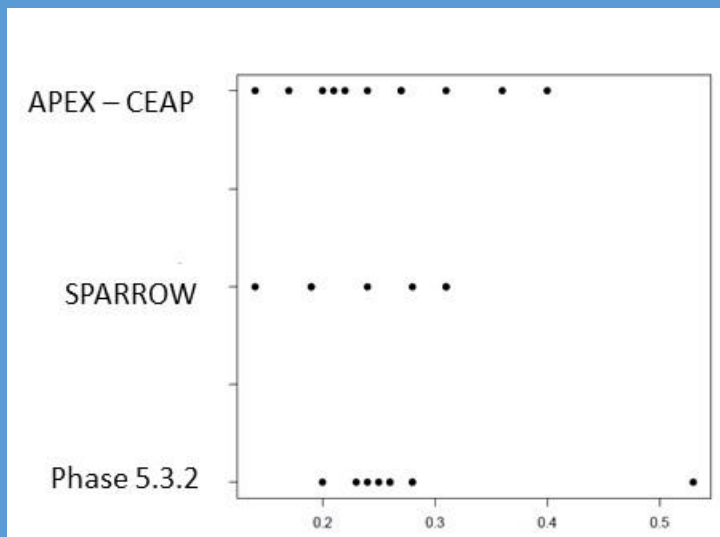
Phase 6 Model Documentation



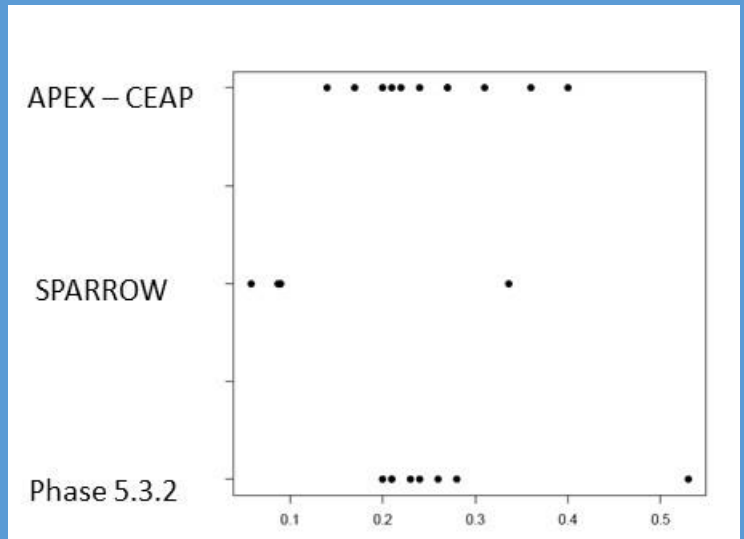
- Sensitivity
  - Change in output per change in input

Nitrogen Sensitivity

Definition – Average Change in export per change in input



Commercial Fertilizer

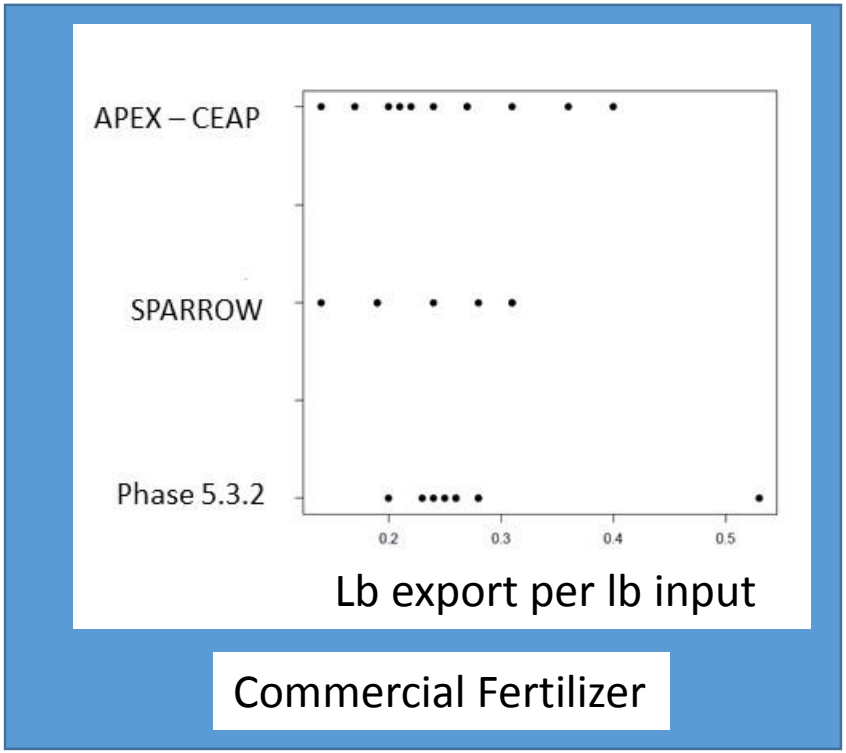


Manure

Multiple Model comparison – All in general agreement on the average effect

Nitrogen Sensitivity

Definition – Average Change in export per change in input



Modeling Workgroup Decision:

Use Phase 5.3.2 for global sensitivities

- Supported by CEAP and SPARROW results
- Answers the right question
  - ***Change*** in export per ***change*** in input
- No direct access to APEX-CEAP
- Sparrow had different land use classifications

Sensitivity of Phase 5 Hightill with Manure land use

	NH3	NO3	ORGN
Atmospheric Deposition	0.01	0.226	0.083
Fertilizer	0.018	0.19	0.073
Manure	0.005	0.067	0.104
Fixation	0.01	0.19	0.101
Crop Uptake	0	-0.057	0
Vegetative Cover	-0.012	0.012	-0.404

Beta 2

Sensitivities are modified according to relative loading rates

P5.3.2 hwm = p6 gwm (grain with manure)

What about other land uses?
Adjust by load ratio => Small Grains is 60% of Grain with manure load

Adjusted sgg sensitivity = gwm sensitivity * 60%

STAC Guidance on Phosphorus

A Review of Agricultural P-dynamics in the Chesapeake Bay Watershed Model

"…output from CBWM [indicated] major reductions in P losses from cropland on the Maryland Eastern Shore that seemed to be inconsistent with research findings and monitoring data in the region."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Presenters
Location
Hosts
The State of the Science of Phosphorus
This symposium drew 350 attendees seeking to better understand the current state of science surrounding phosphorus transport, soil dynamics, legacies, modeling, and its impact on water quality. Experts on the science of phosphorus from across the country were featured on the program.
Visit the Phosphorus Symposium playlist to watch presentations by selecting individual sessions or play all for continuous play of the program. Proceedings are also available in PDF format to download.
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Phosphorus Conceptual Model

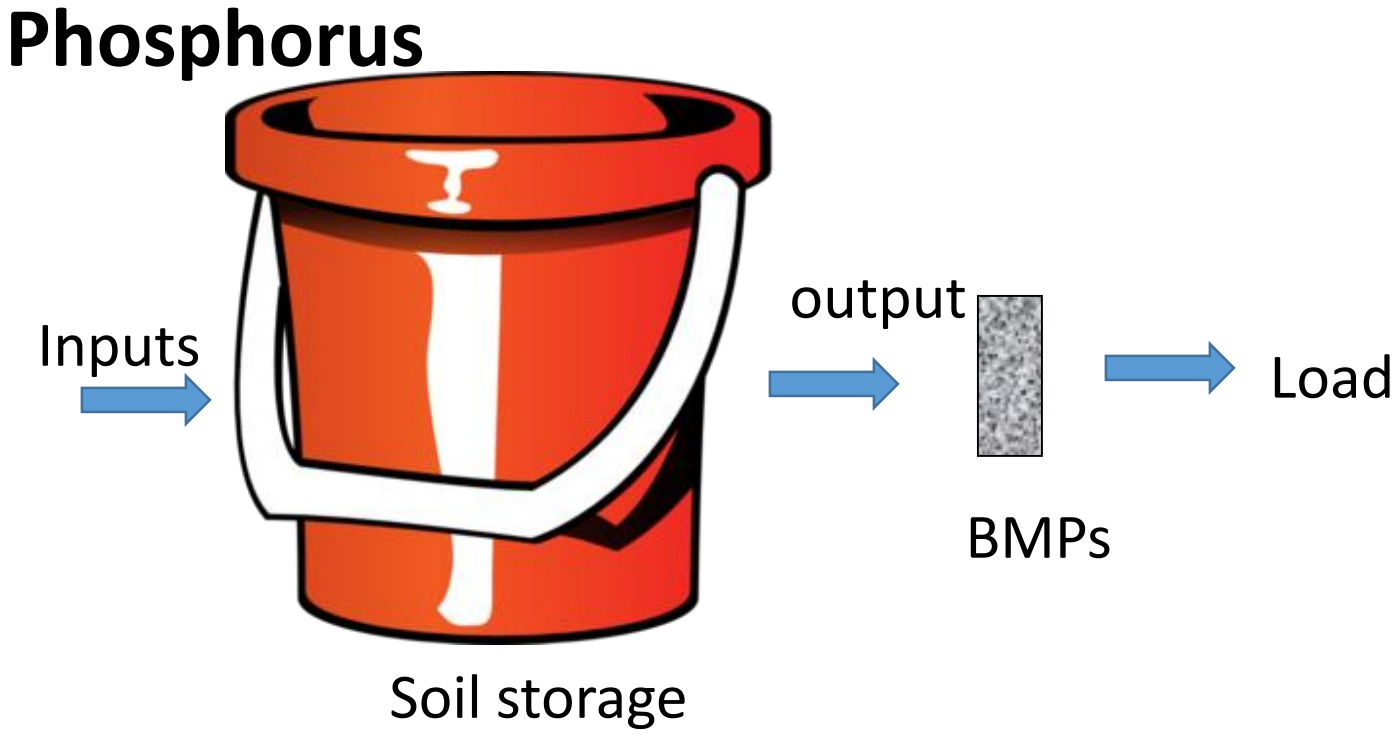
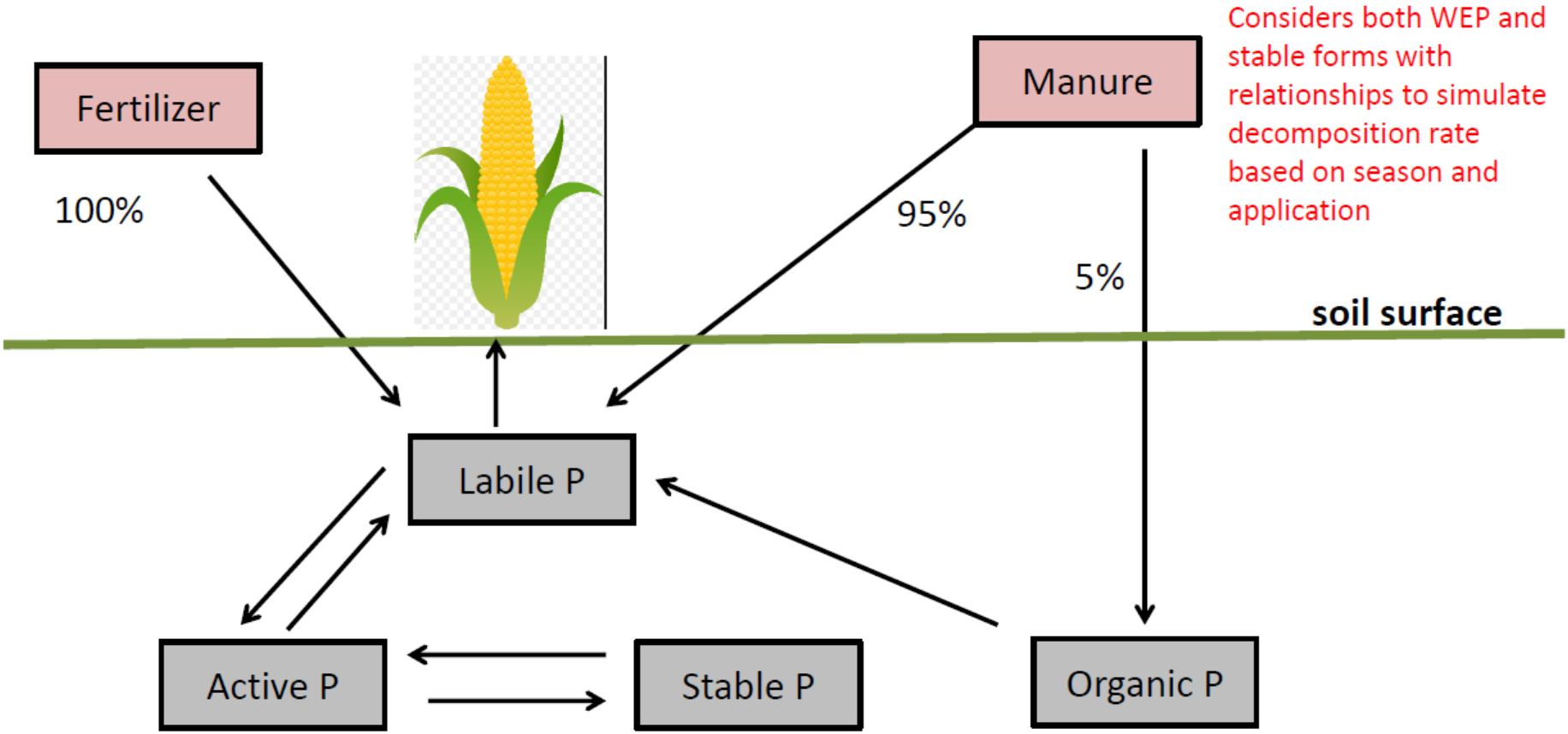


Diagram of APLE Nutrient Sources and Soil Pools

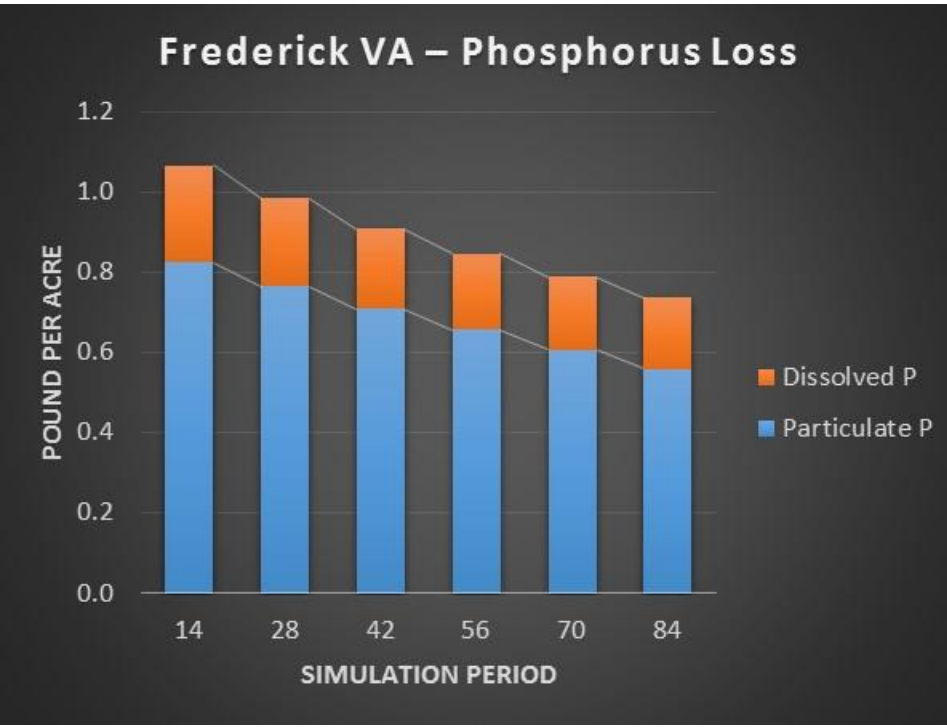


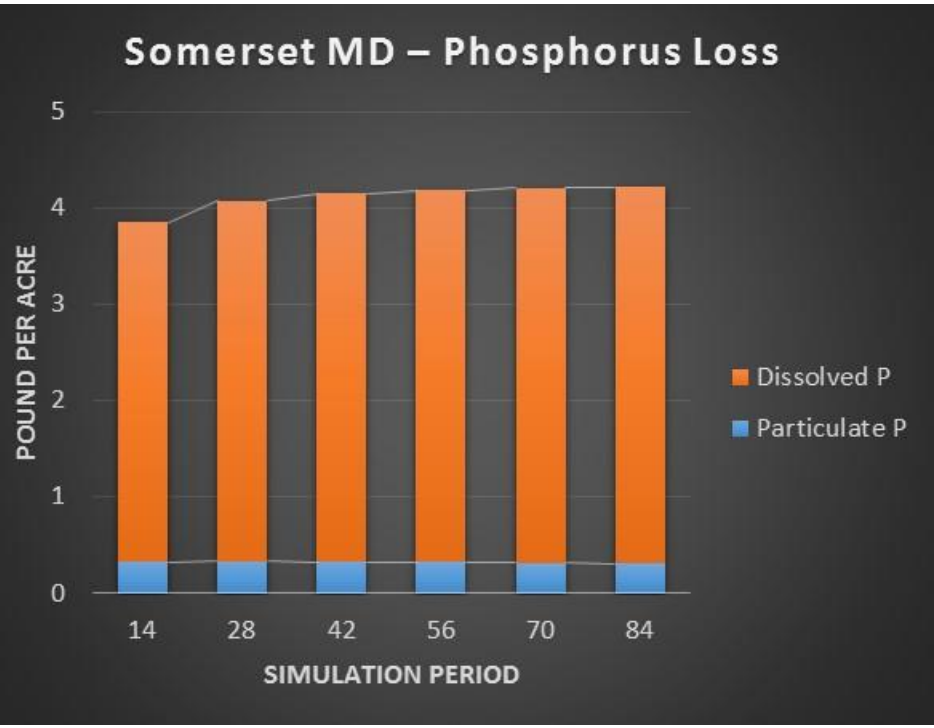
Equations to estimate Manure runoff P, Fertilizer runoff P, Sediment P loss, and Dissolved Soil P runoff

(Adapted from Vadas, et al. 2007)

Low input County

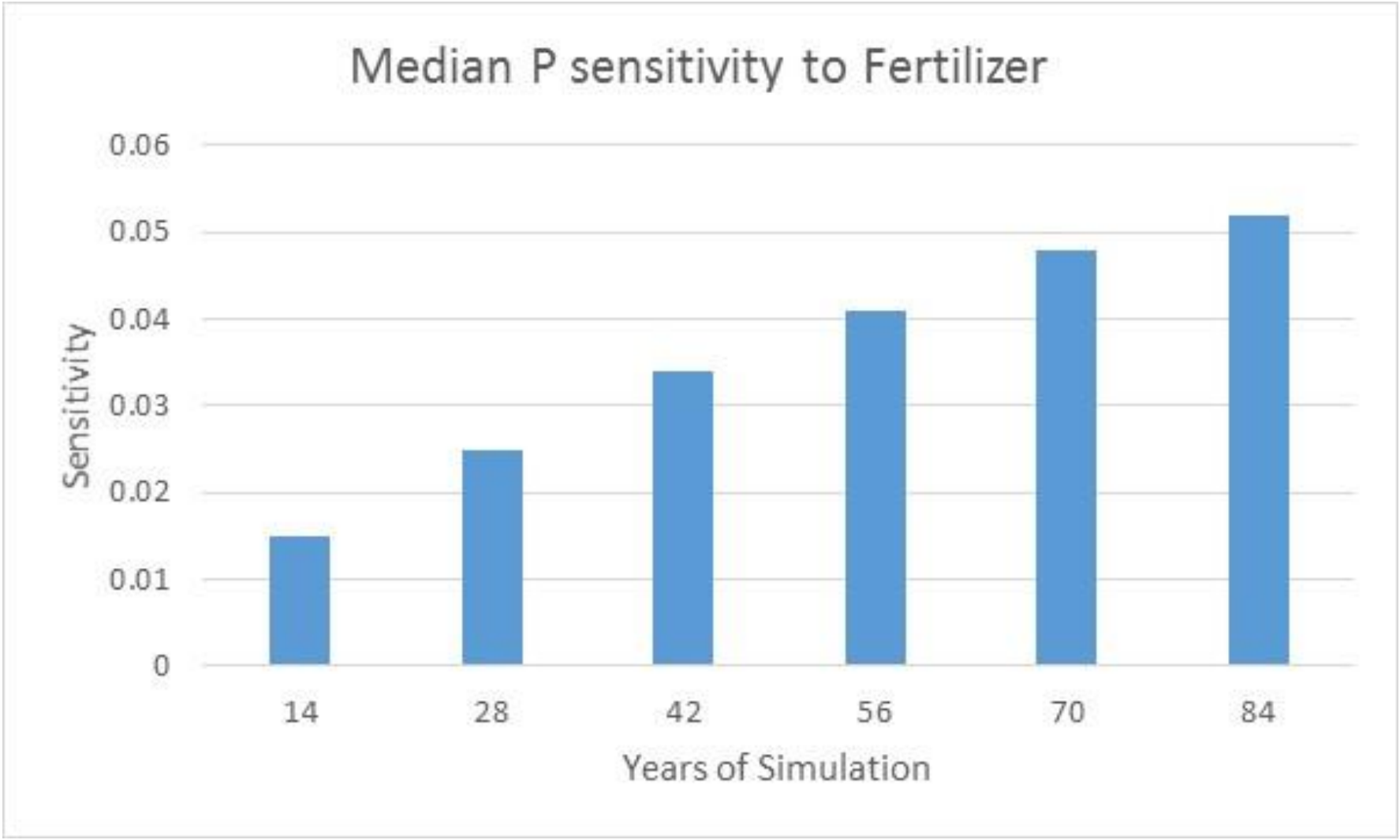
High input County





The concept of a sensitivity to inputs is problematic because the long term simulations do not level off

Different Simulation Periods to Evaluate Sensitivities



APLE Hightill Landuse Sensitivities using Constant Mehlich 3 Soil P

Table 1. Phosphorus Loss APLE Model Sensitivity to change in inputs				
Inputs	**Units**	**MEDIAN SLOPE**	**MEDIAN SR**	**Relative Sensitivity**
Mehlich	ppm	0.015	0.696	Sensitive
Sediment	ton/ac	0.168	0.633	Sensitive
Runoff	inches	0.057	0.403	Moderately sensitive
Manure	lbs/acre	0.007	0.111	Slightly sensitive
Fertilizer	lbs/acre	0.004	0.068	Slightly sensitive
Uptake	lbs/acre	0	0	Insensitive

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~~Fertilizer~~	~~lbs/acre~~	~~0.004~~	~~0.068~~	Slightly sensitive
~~Uptake~~	~~lbs/acre~~	~~0~~	~~0~~	Insensitive

Requires estimate of soil P

Summary of Soil P data sources

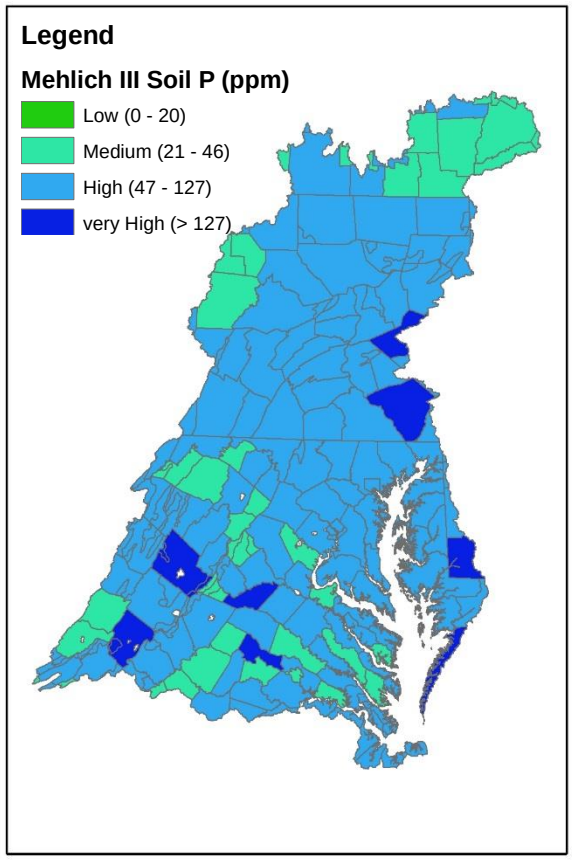
SOURCE	YEARS	LOCATION	UNITS	SAMPLE TYPE
AgriAnalysis	2003 - 2014	DE,MD,NY,PA,VA,WV	Phos lbs/ac	by county & zip code
Penn State University	2001 - 2014	PA	Mehlich III soil P (ppm)	by county and by crop
Virginia Tech Soil Testing Lab	Average of 2012-2014	VA	Mehlich III soil P (ppm)	by county and by crop
University of Maryland	1954 - 2002	MD	number of samples	by county
University of Maryland	1992	DE,MD,NY,PA,VA,WV	Mehlich III soil P (ppm)	by county

Soil P Landuse Ratios

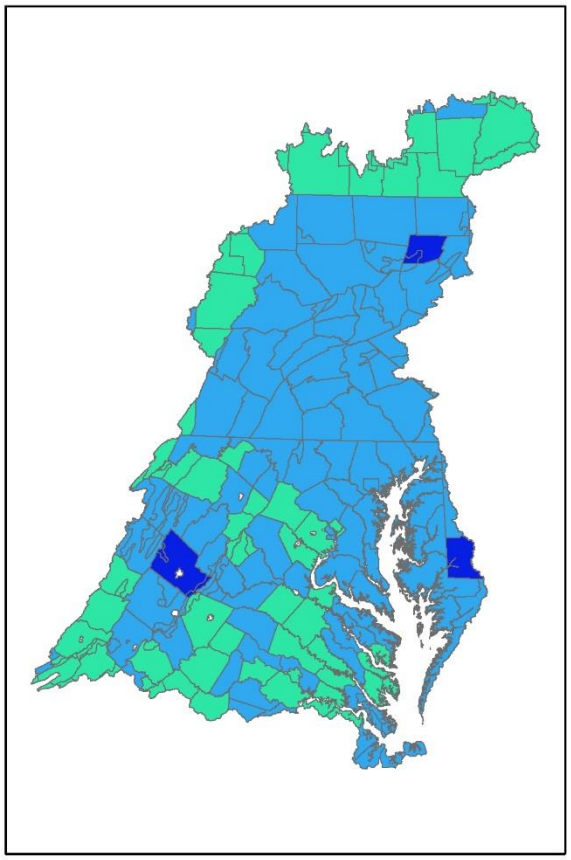
Landuse	Landuse name	PA		VA	
		Average Mehlich III	Ratio	Average Mehlich III	Ratio
ALL	ALL	102		85	
sch	Specialty Crop High	190	1.9	146	1.7
scl	Specialty Crop Low	151	1.5	120	1.4
oac	Other Agronomic Crops	132	1.3	106	1.3
swm	Silage with Manure	90	0.9	88	1.0
gwm	Grain with Manure	89	0.9	76	0.9
soy	Full Season Soybeans	83	0.8	64	0.8
sgg	Small Grains and Grains	76	0.7	72	0.8
ohy	Other Hay	73	0.7	58	0.7
lhy	Legume Hay	73	0.7	58	0.7
pas	Pasture	66	0.6	56	0.7

- PA and VA provided soil P data by crop.
- The average soil P ratios were applied to other states' soil P datasets.

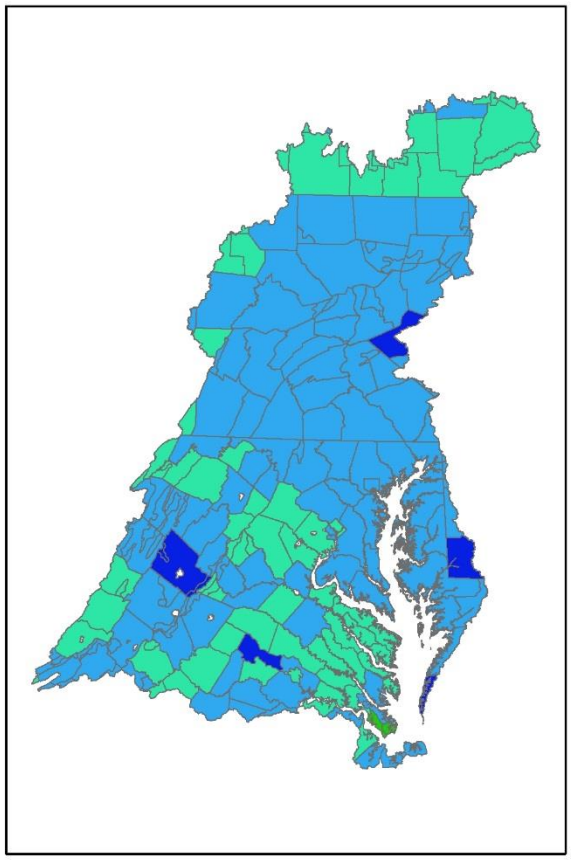
Small Grains and Grains (sgg)



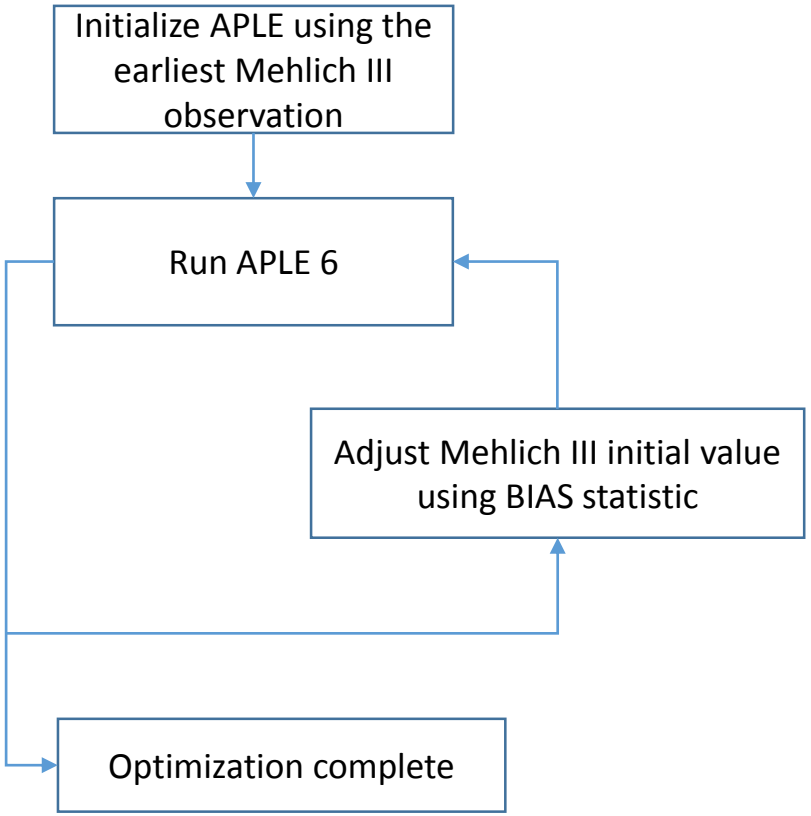
Other Hay (ohy)

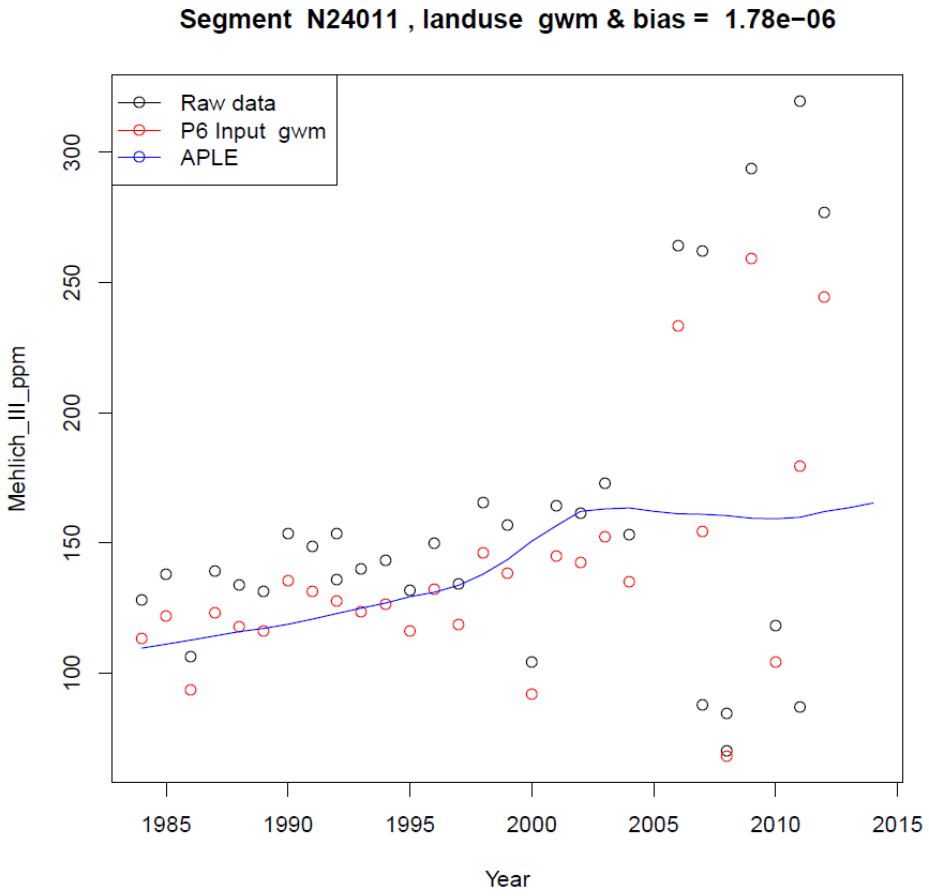


Legume Hay (lhy)



Soil P History



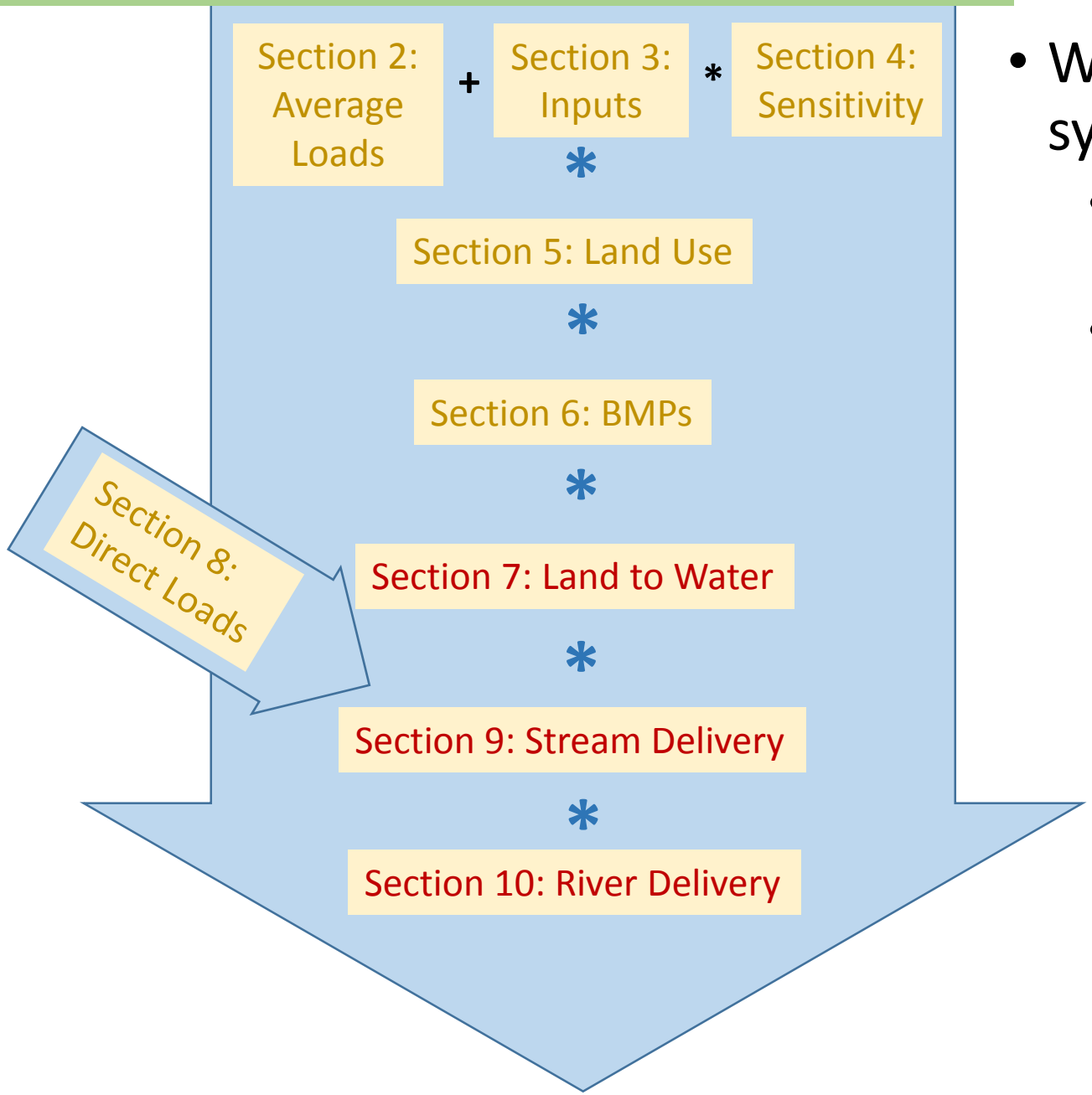


Review Strategy

- Read Chapter 1
- Target Chapters and Sections that are important to you

- Main Prediction of CAST for decision support:
  Change in Anthropogenic Load
  - BMPs
  - WWTP
  - Land use Change
  - Response to Change in inputs

Phase 6 Model Documentation

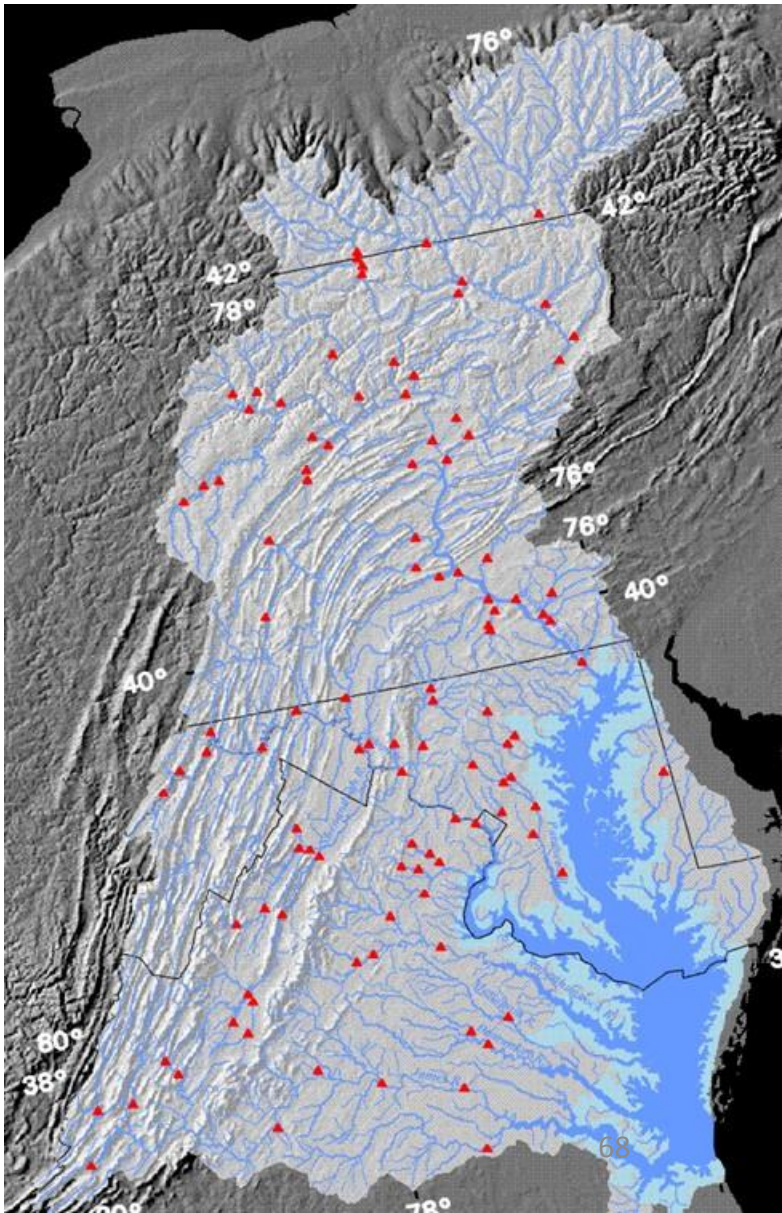


- Watershed Delivery system
  - Spatially distribute loads
  - Check for agreement with monitoring data
    - Modeling workgroup

$$LOAD_i = \left\{ \sum_{j \in J(i)} \left[\sum_{n=1}^{N} S_{n,j} \beta_n \exp(-\alpha' Z_j) \right] \prod_m \exp(-\delta_m^s T_{i,j,m}) \prod_l 1/(1+\lambda^r q_{i,j,l}^{-1}) \right\} \exp(\varepsilon_i)$$

USGS Sparrow Model

- Regression Model
- Gain knowledge about the watershed based on observations



Phase 6 Model Structure

$$LOAD_i = \left\{ \sum_{j \in J(t)} \left[\sum_{n=1}^{N} S_{n,j} \beta_n \exp(-\alpha' Z_j) \right] \prod_m \exp(-\delta^s{}_m T_{i,j,m}) \prod_l 1/(1 + \lambda^r q_{i,j,l}^{-1}) \right\} \exp(\varepsilon_i)$$

Average Load + Δ Inputs * Sensitivity

*

Land Use Acres

*

BMPs

*

Land to Water

*

Stream Delivery

*

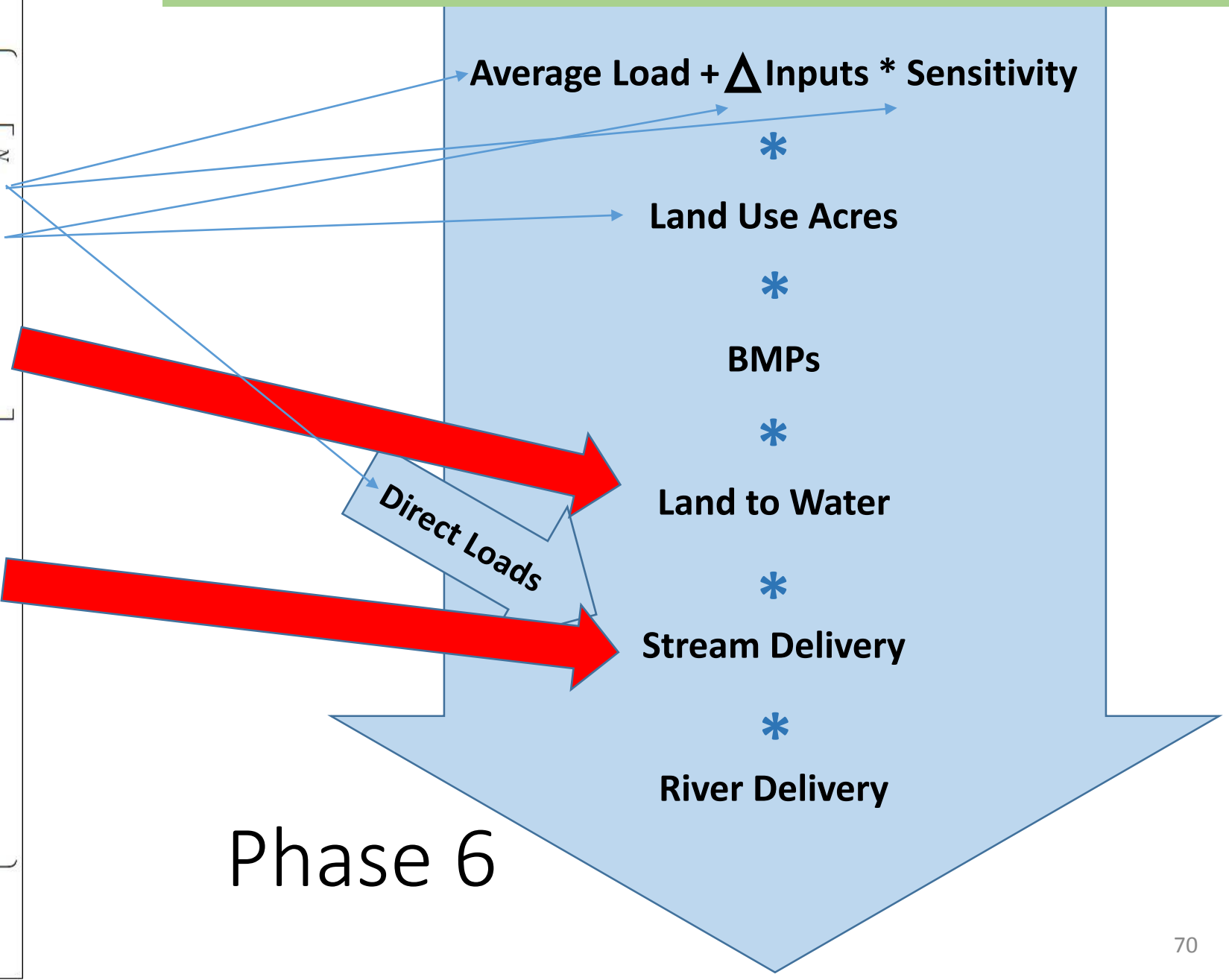
River Delivery

Direct Loads

Phase 6

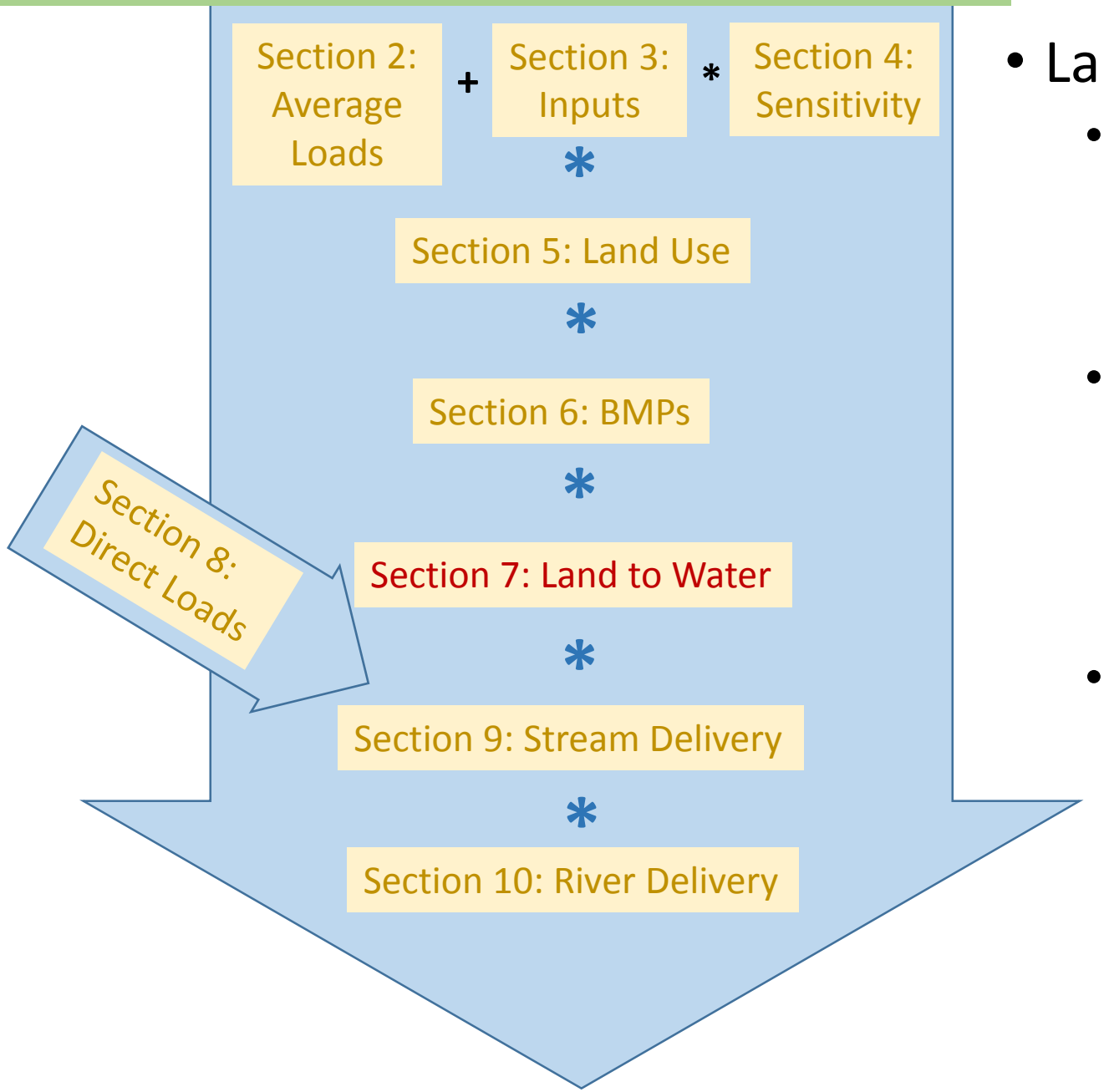
Phase 6 Model Structure

$$LOAD_i = \left\{ \sum_{j \in J(i)} \left[\sum_{n=1}^{N} S_{n,j} \beta_n \exp(-\alpha' Z_j) \right] \prod_m \exp(-\delta^s_m T_{i,j,m}) \prod_l 1/(1 + \lambda^r q^{-1}_{i,j,l}) \right\} \exp(\varepsilon_i)$$



Phase 6

Phase 6 Model Documentation



- Land to Water
  - Loads are already edge-of-stream but based on large averages
  - L2W factors spatially distribute the loads based on watershed characteristics
  - L2W factors have no net effect on the overall loads

Catchment and Reach Attributes Used in SPARROW Models

Explanatory Variable	Nitrogen	Phosphorus
Land-to-Water Delivery	1. % catchment in Piedmont carbonate 2. Groundwater discharge 3. Available soil water capacity 4. Enhanced vegetative index	1. % catchment in Coastal Plain 2. Precipitation * 3. Soil erodibility * 4. well-drained soils

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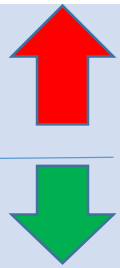
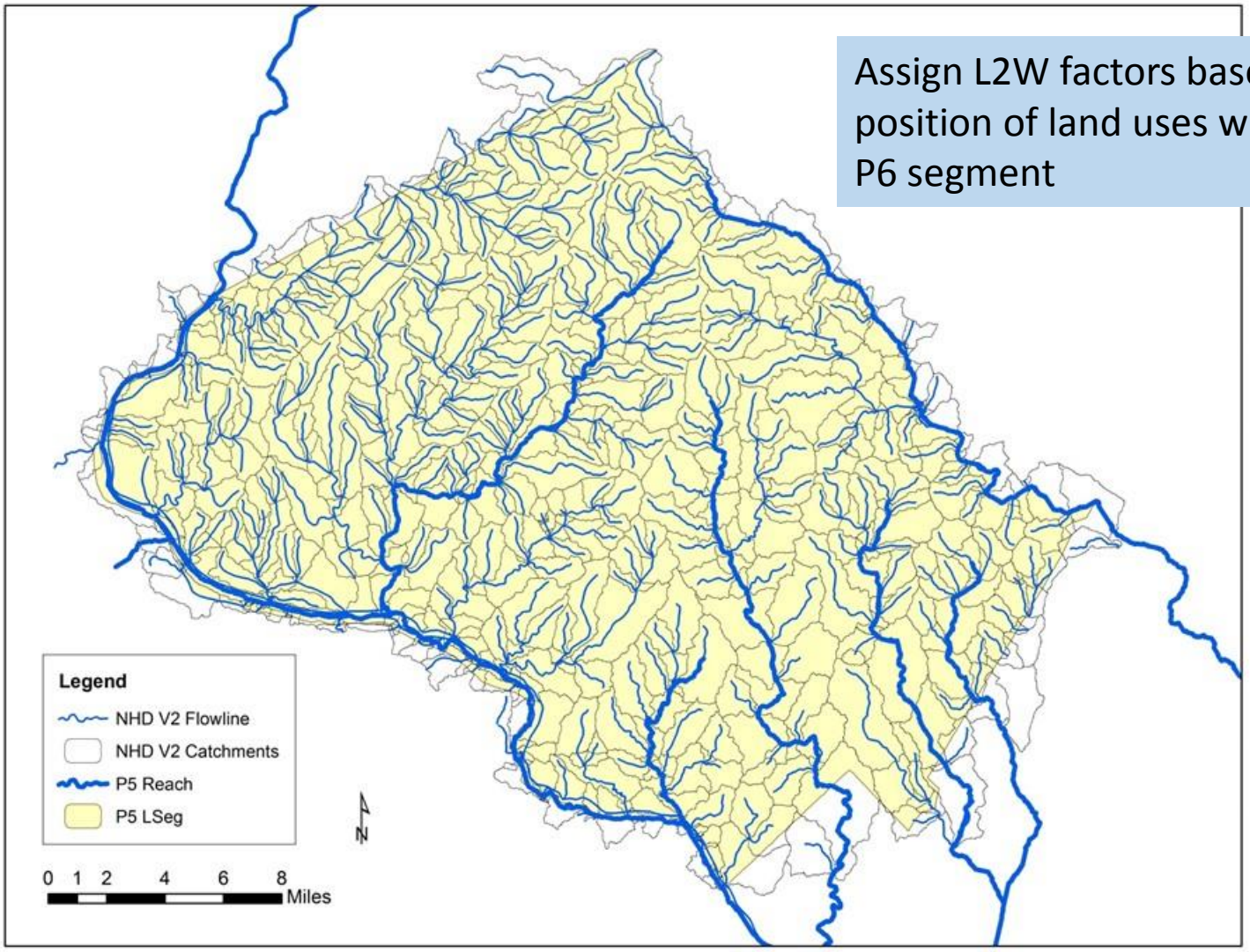


* Not used in Beta 2 calculations because redundant with APLE sensitivities to runoff and erosion

Comparison of NHD+ and P6 Scales

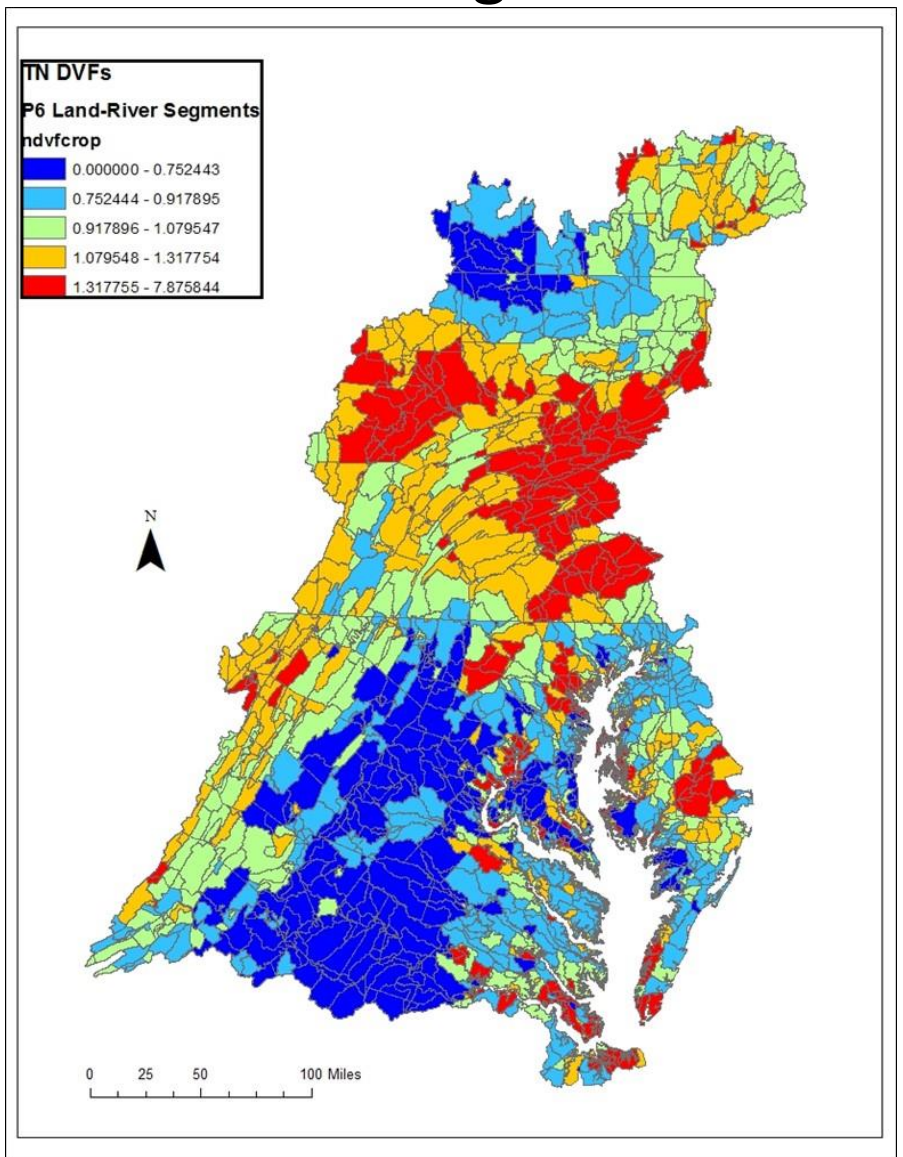


Assign L2W factors based on position of land uses within P6 segment

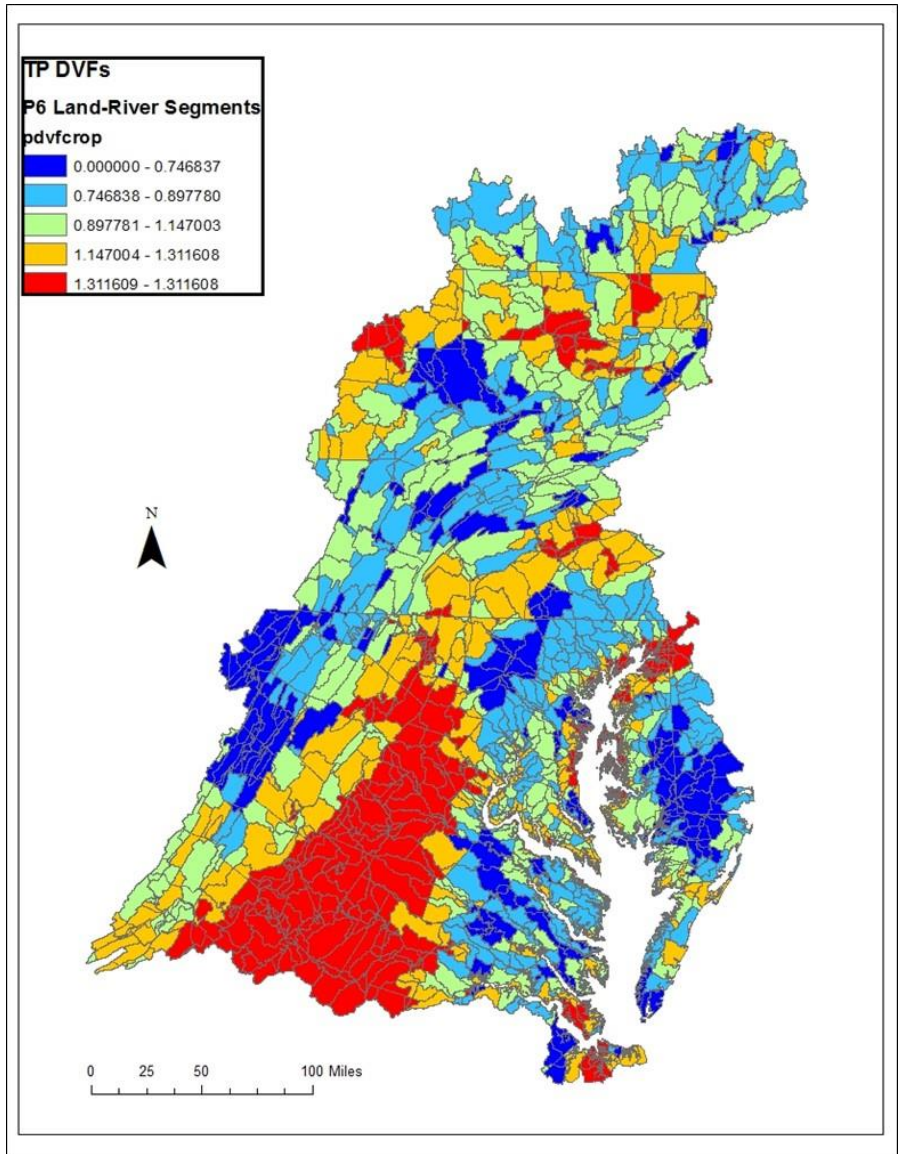
Crop L2W Factors

Beta 2

Nitrogen



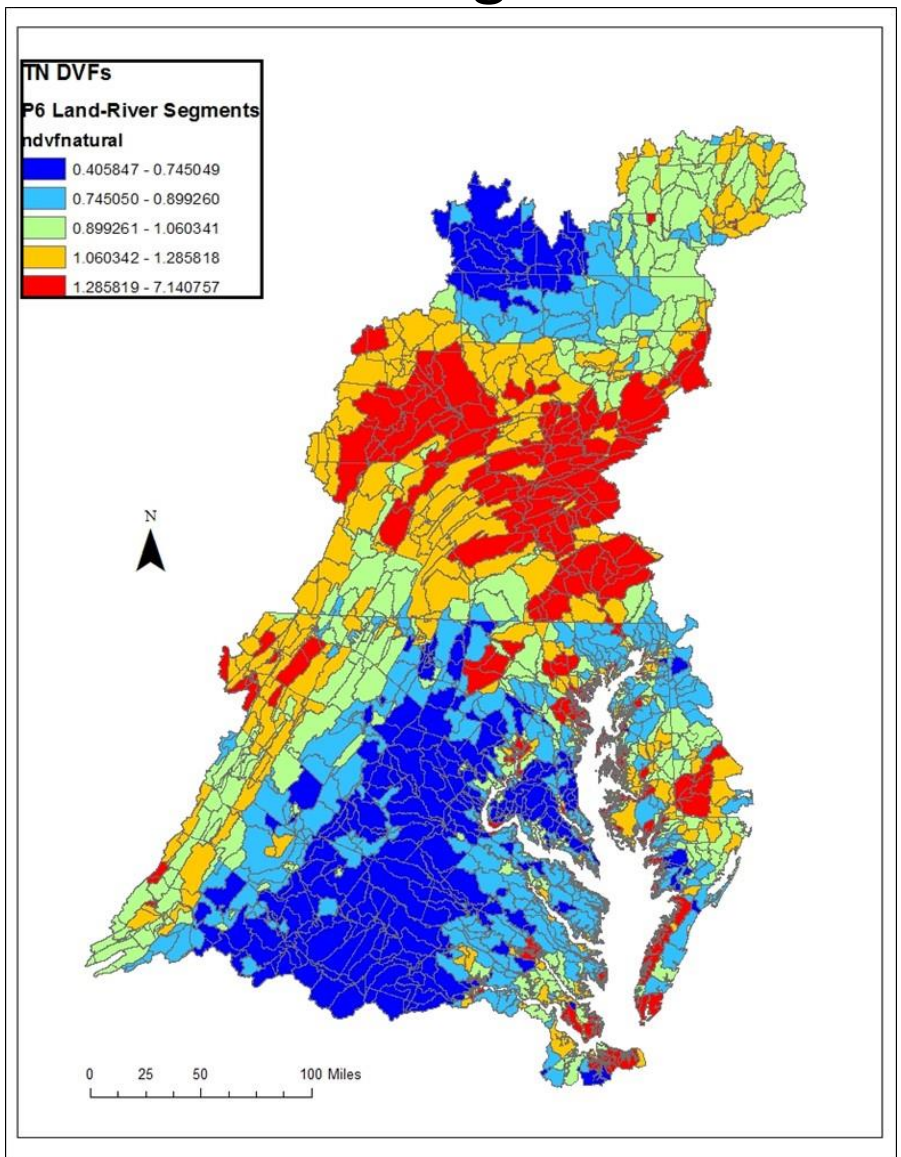
Phosphorus



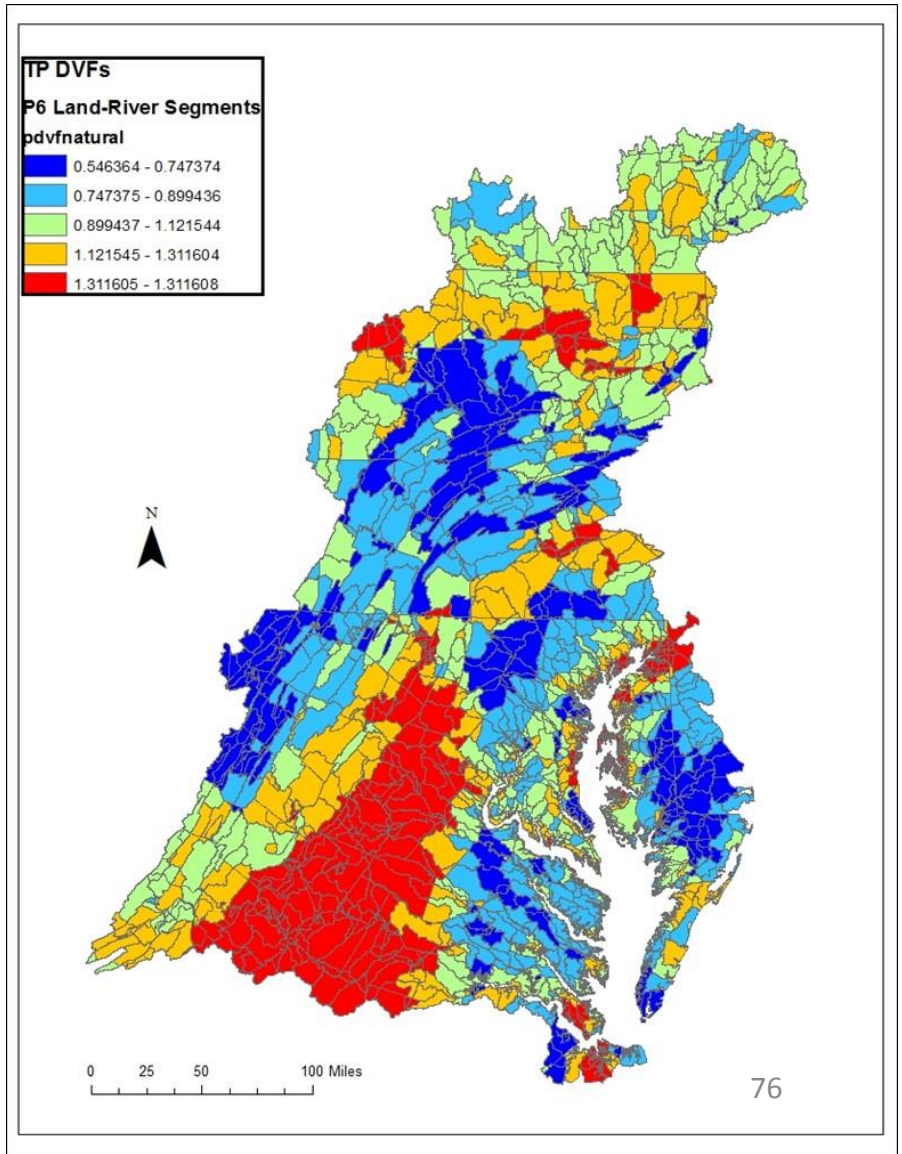
Natural L2W Factors

Beta 2

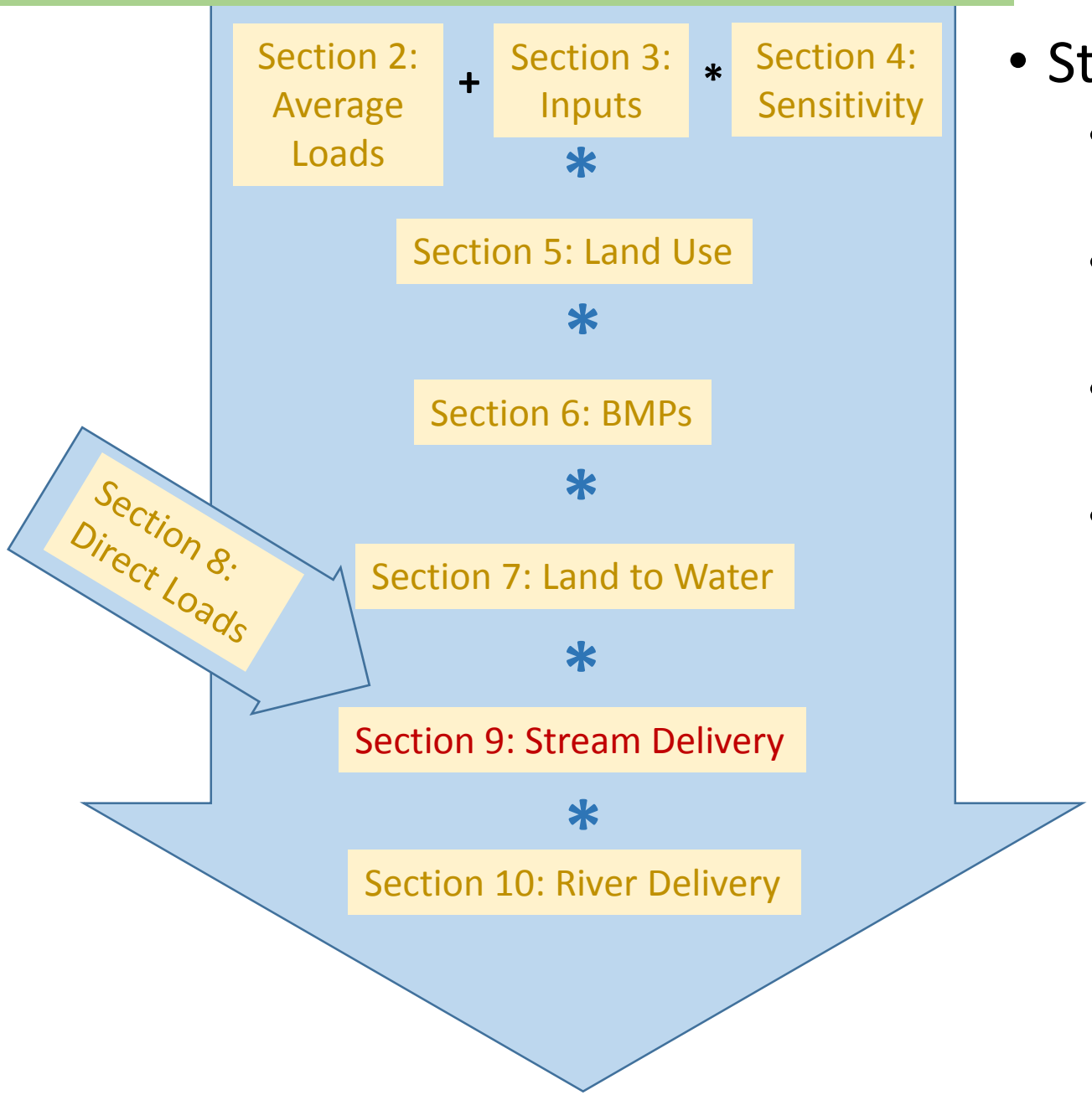
Nitrogen



Phosphorus



Phase 6 Model Documentation

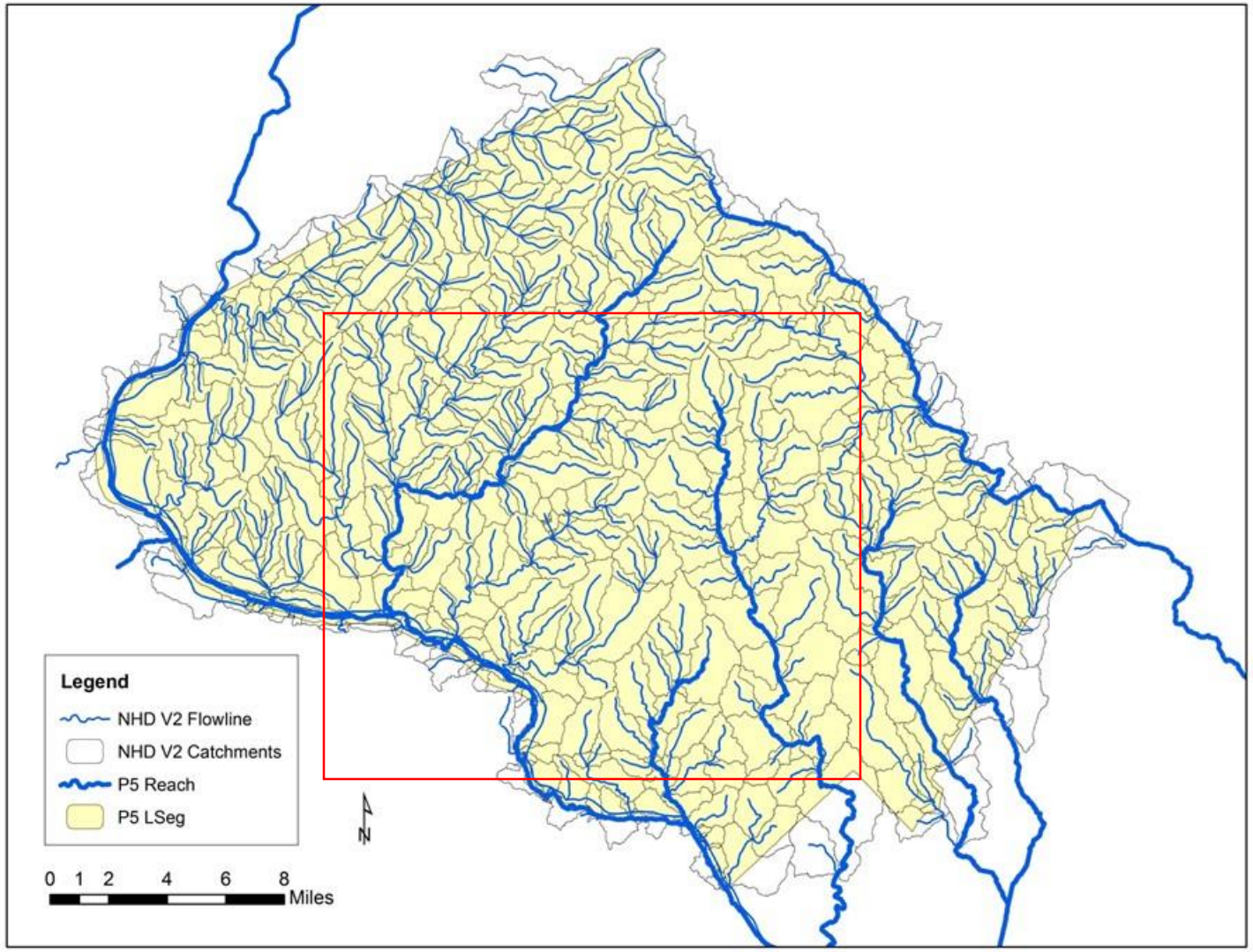


- Stream Delivery
  - The effect of small streams
  - Roughly 1st – 3rd order
  - Smaller than a river segment
  - Not simulated with HSPF

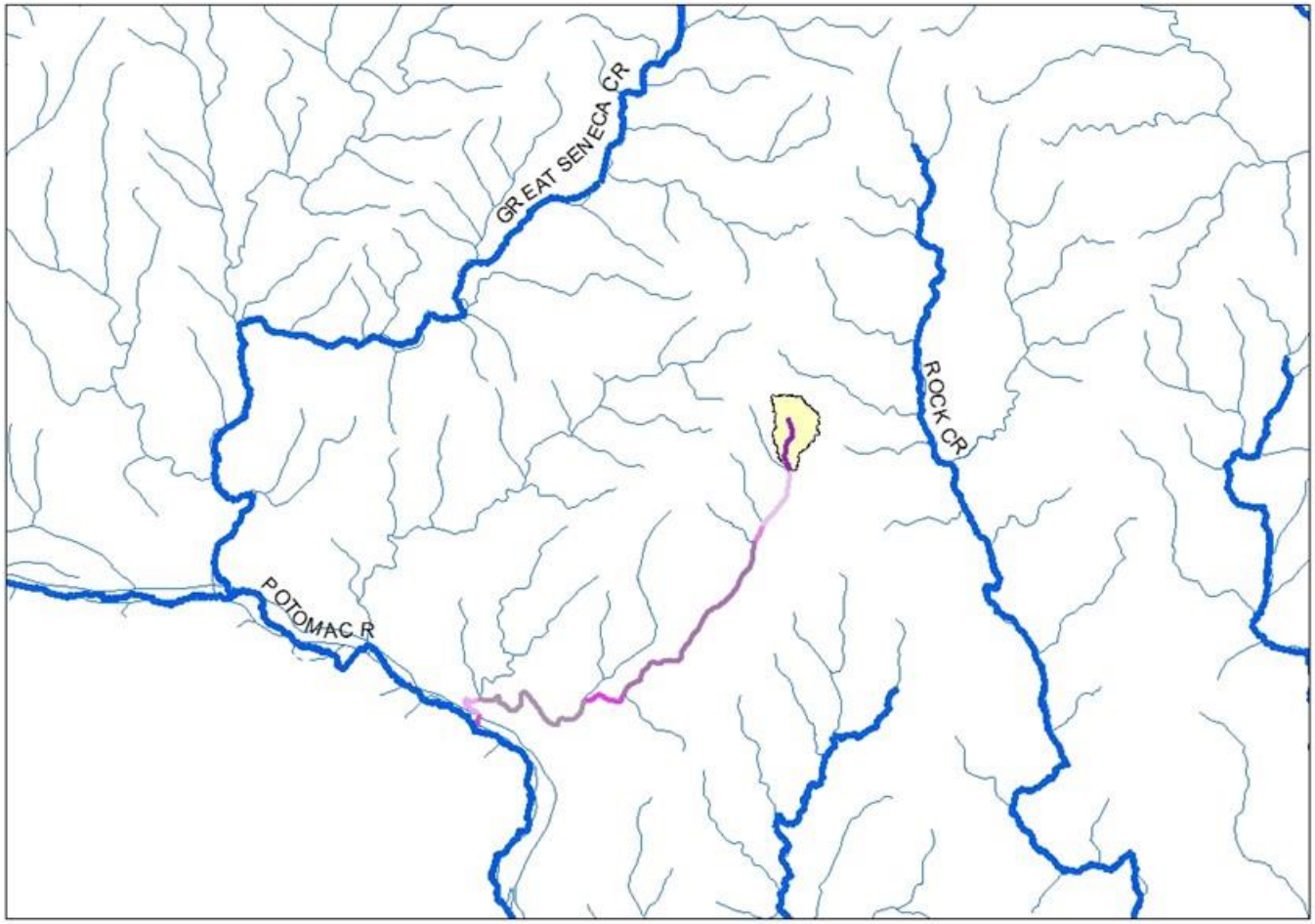
Catchment and Reach Attributes Used in SPARROW Models

Explanatory Variable	Nitrogen	Phosphorus
Stream-to-River Factors (Aquatic Decay)	Impoundments: Hydraulic loading rate Rivers and streams: Average annual temperature Travel time	Impoundments: Hydraulic loading rate Rivers and streams: No losses represented

Comparison of NHD+ and P6 Scales



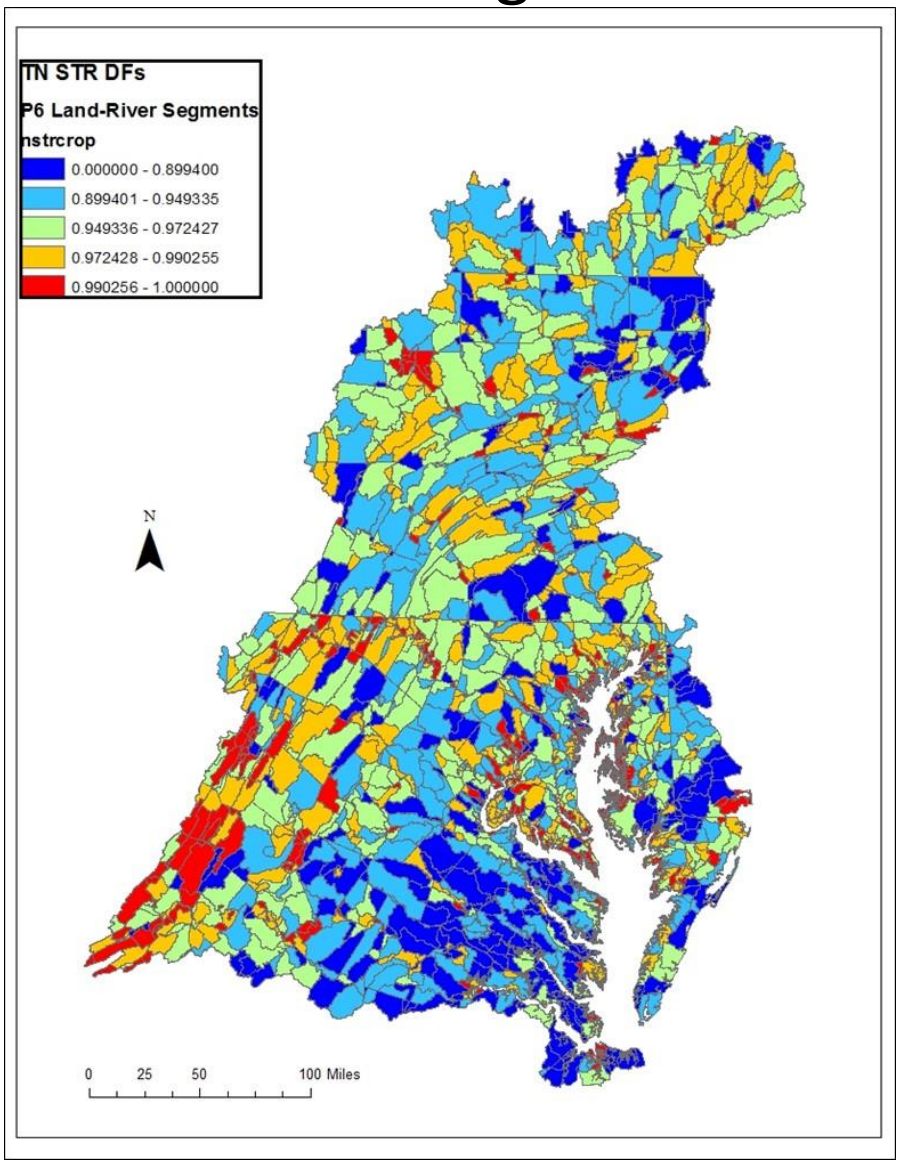
Transport Path from NHD+ Catchment to P6 River Reach



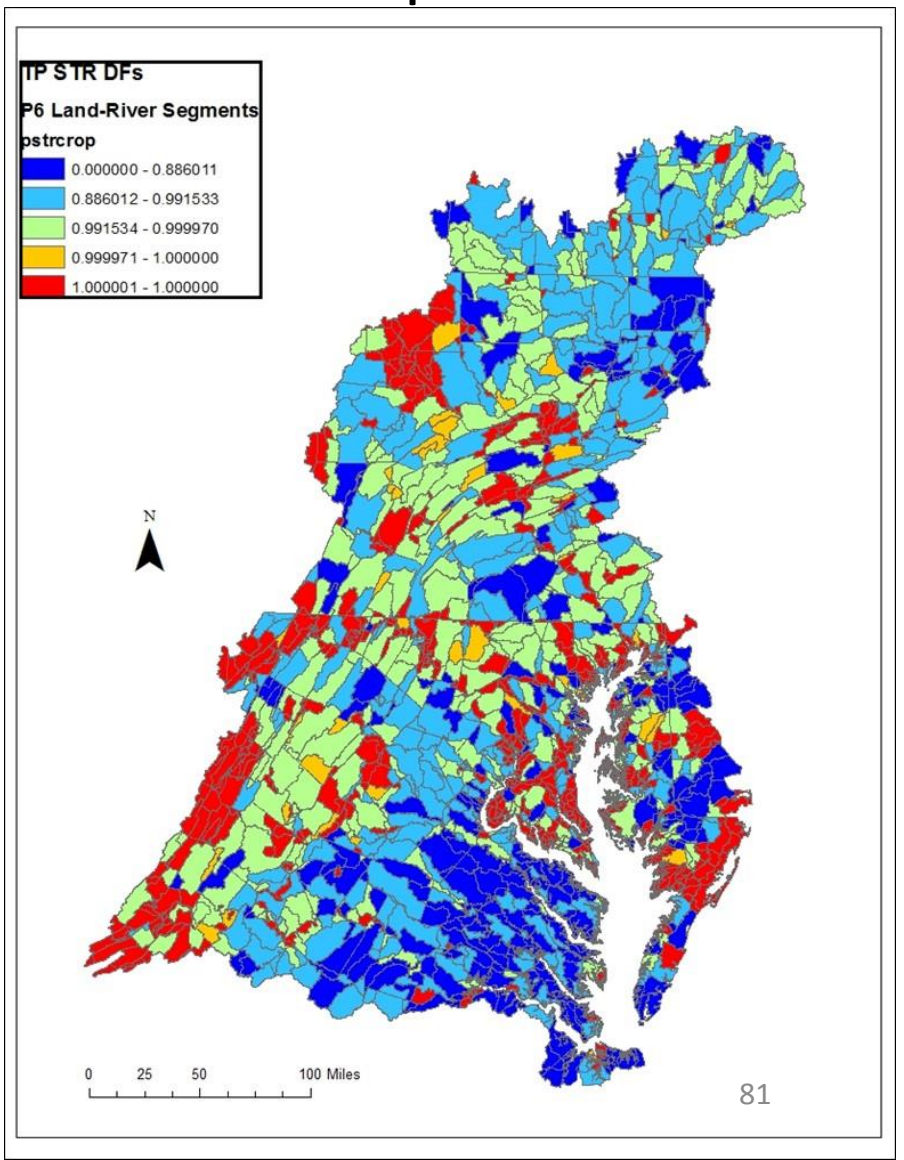
Stream-to-River Delivery Factors

Beta 2

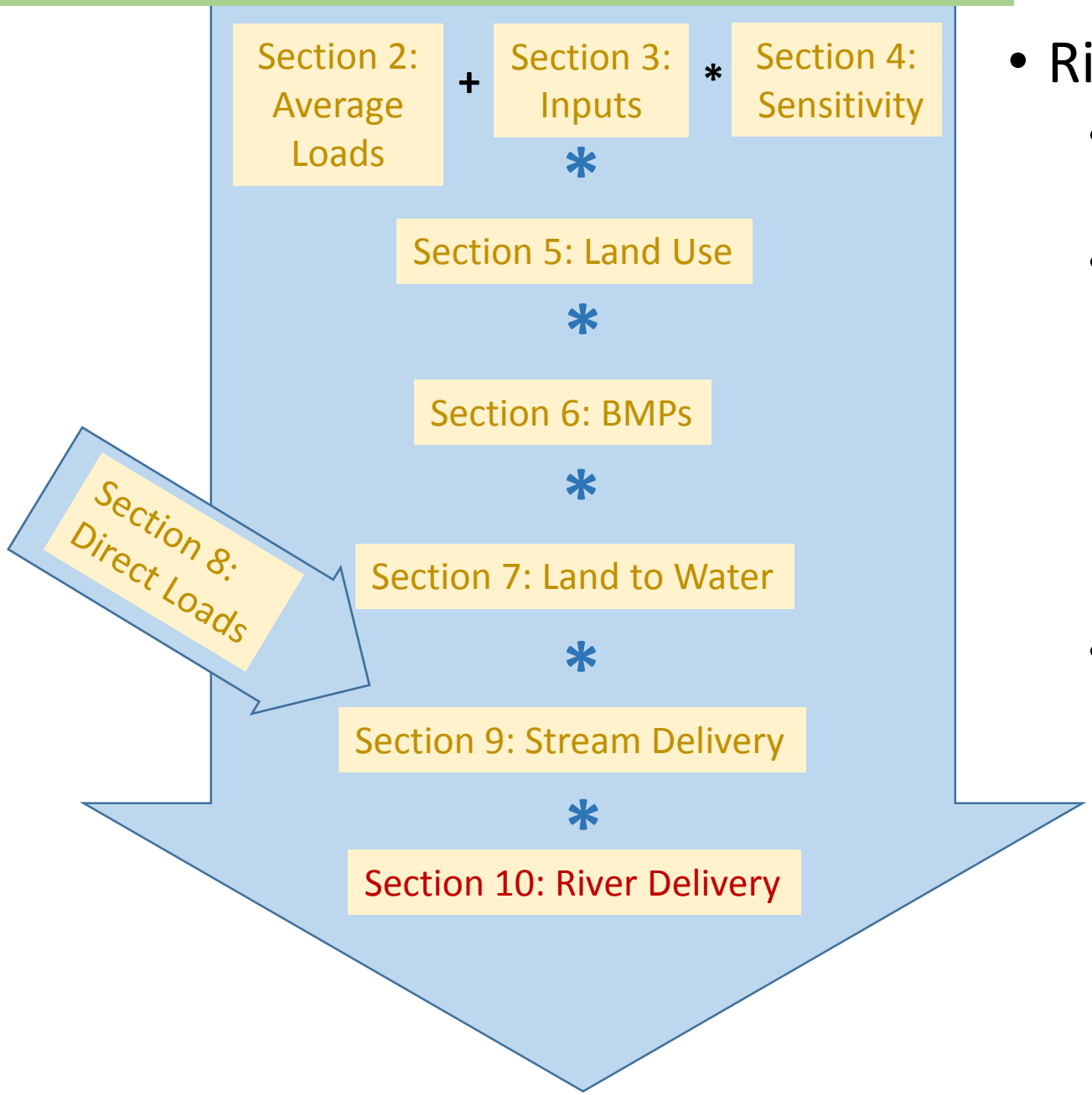
- Nitrogen



- Phosphorus

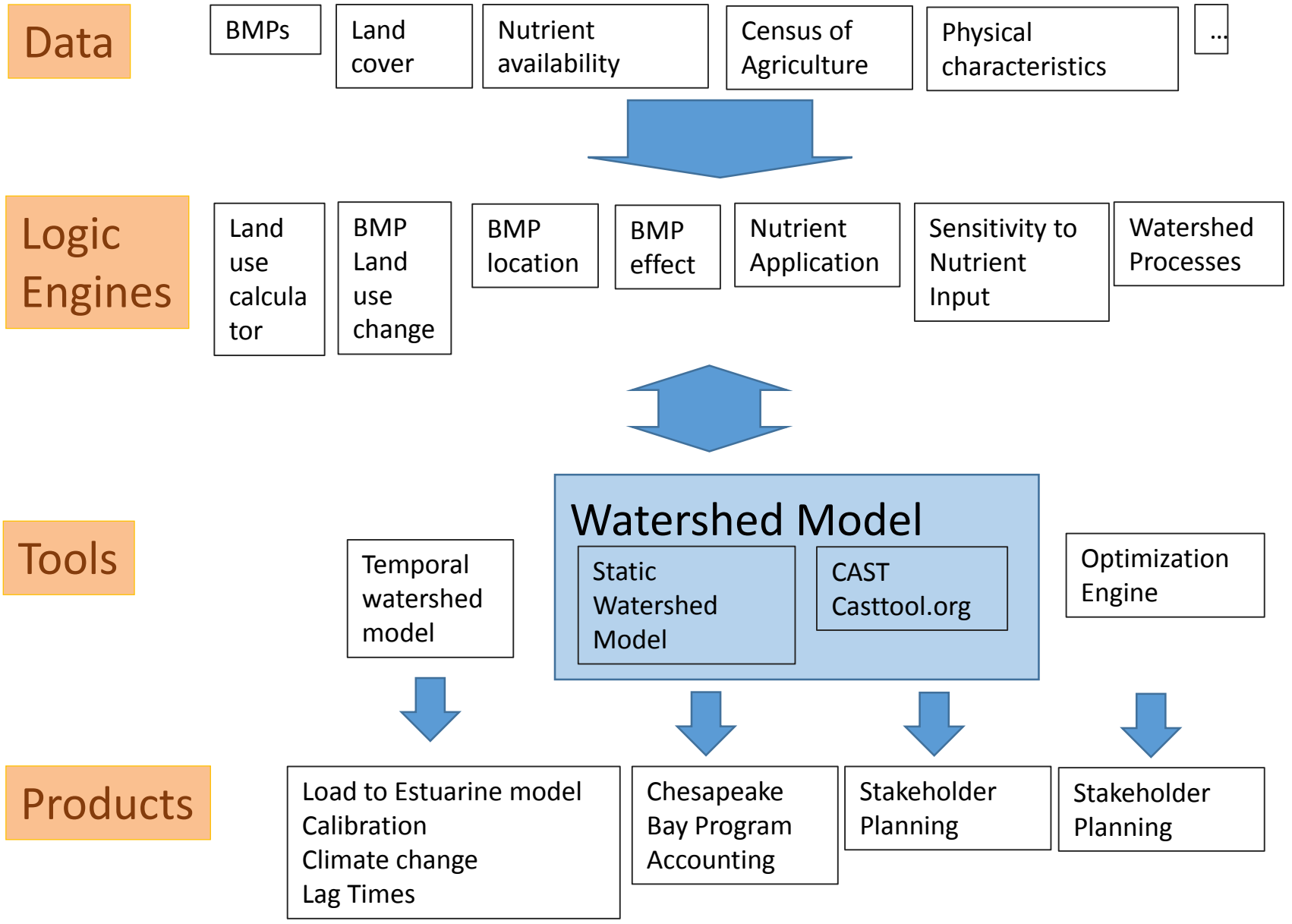


Phase 6 Model Documentation



- River Delivery
  - The effect of large rivers
  - Each river segment has exactly one large river
    - except for some coastal plain segments with no river
  - Simulated with HSPF

CAST = WSM = Scenario Builder



Data

Logi
Engi

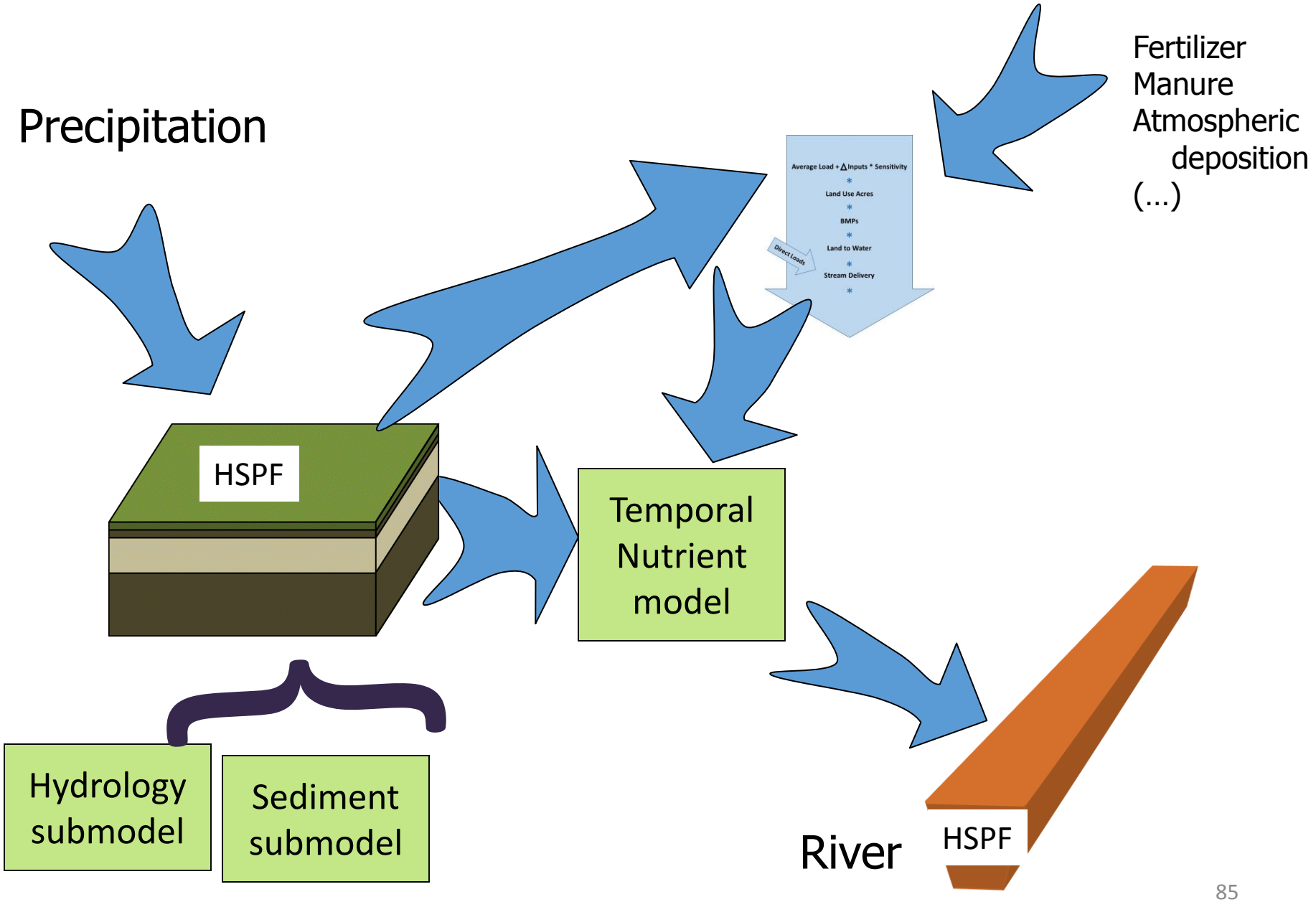
Tool

Proc

Temporal model uses

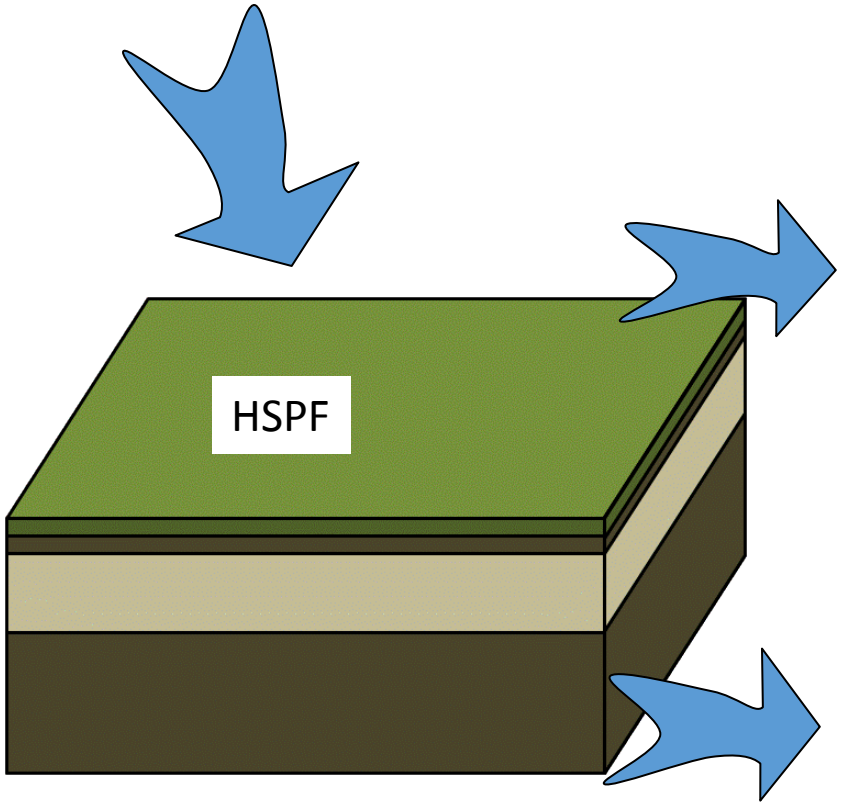
- **Calibrate the watershed model to observations**
  - Make sure the entire system matches observations
- **Supply parameters to the simulation of nutrients**
  - Flow and sediment are needed as inputs for the sensitivity calculation
- **Create Input loads for the estuarine model**
  - Need temporal and spatial loads
- **Investigate emergent watershed response**
  - Climate change
  - Lag times
- **Estimate delivery factors for simulated rivers**
  - The last box in the ‘simple p6 model’

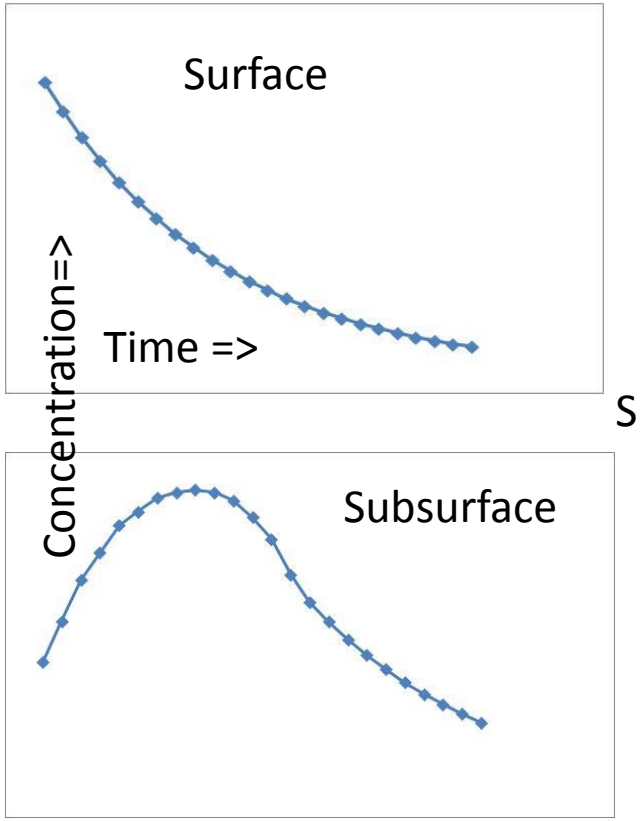
Model to compare against Observations



Lag Models - Nitrogen

Each Loading Event



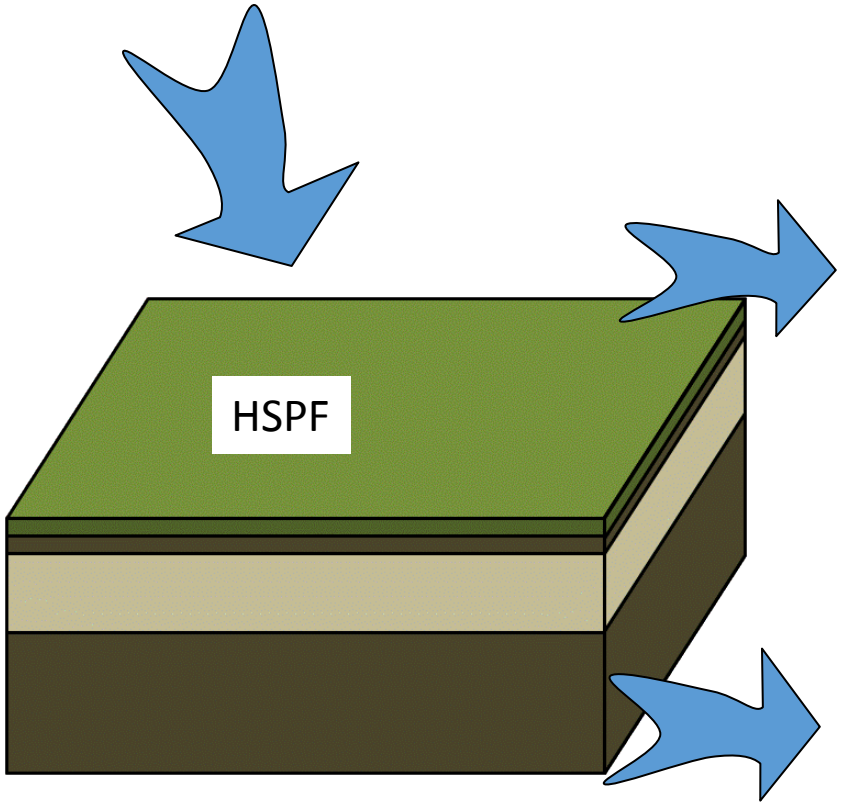


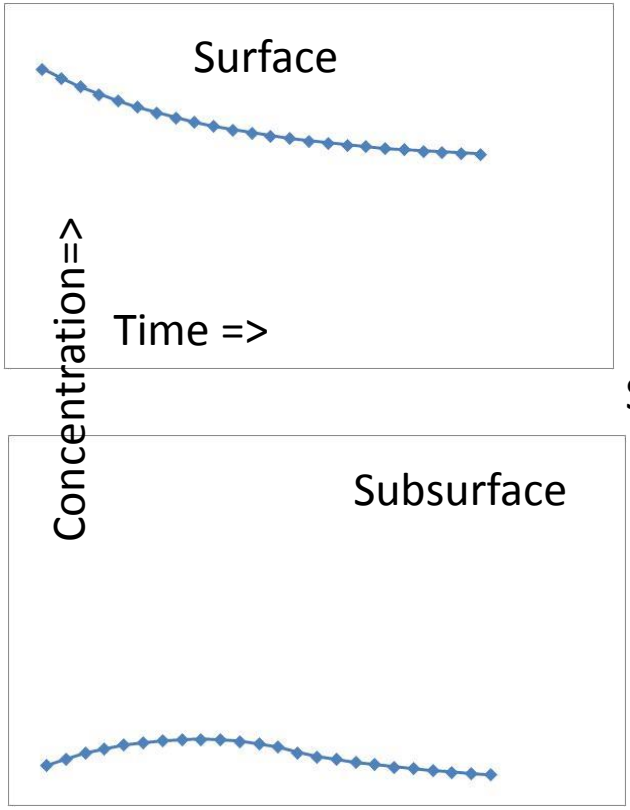
Sum=

Nutrient Submodels

Lag Models - Phosphorus

Each Loading Event

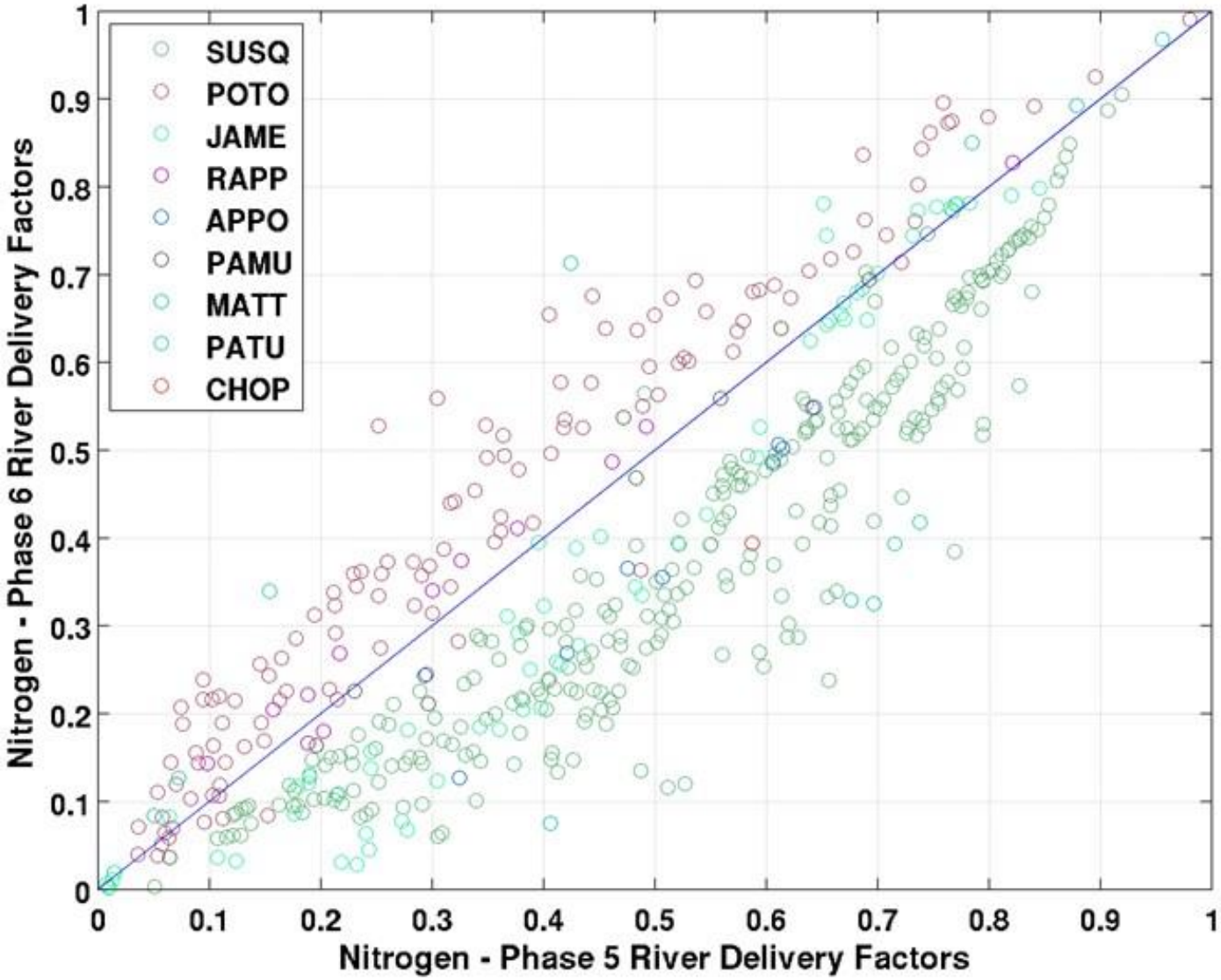




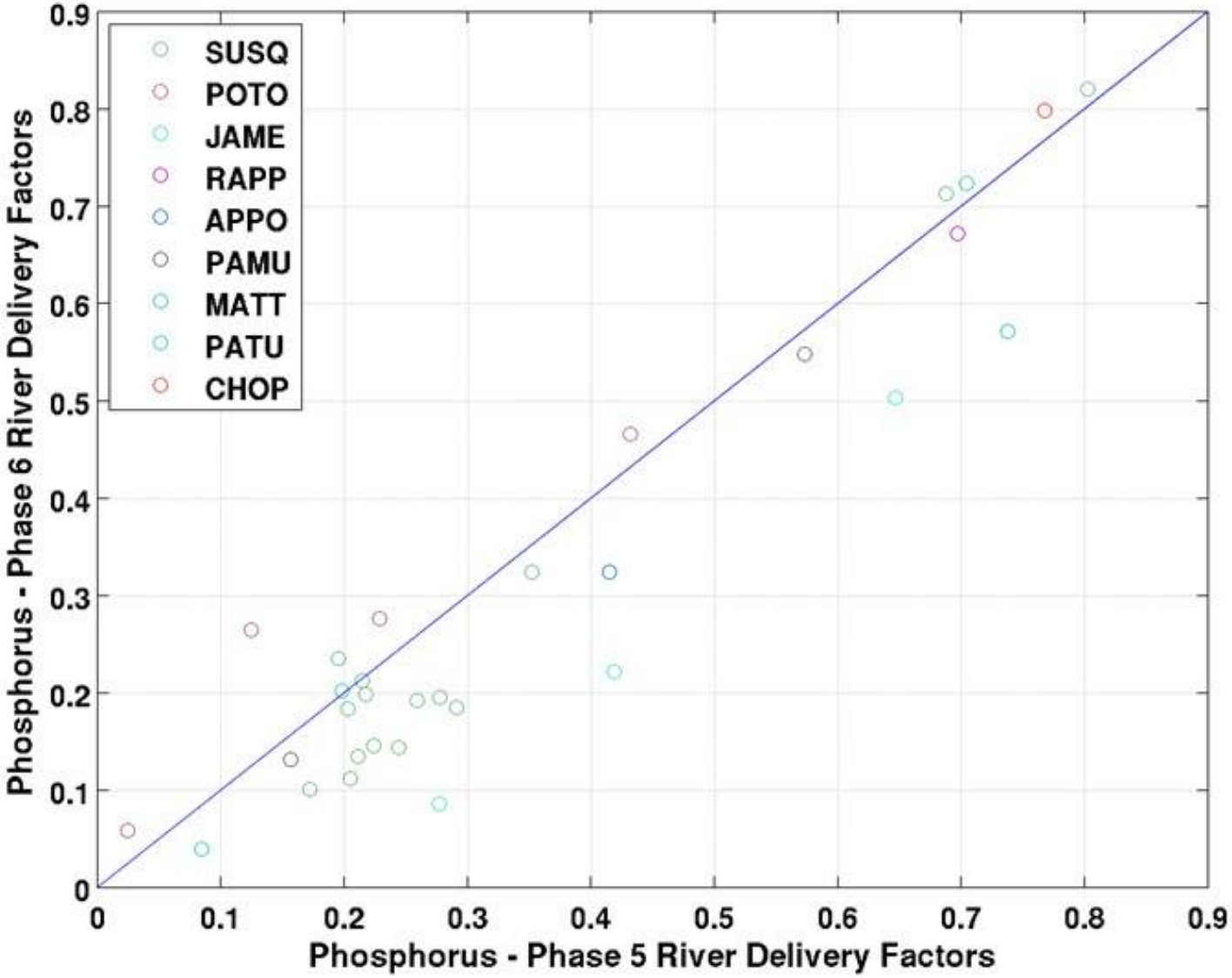
Sum=

Nutrient Submodels

Nitrogen delivery factors



Phosphorus delivery factors



Moment of Truth

- Phase 5 – Complex process model
- Phase 6 - Simple models built of consensus decisions

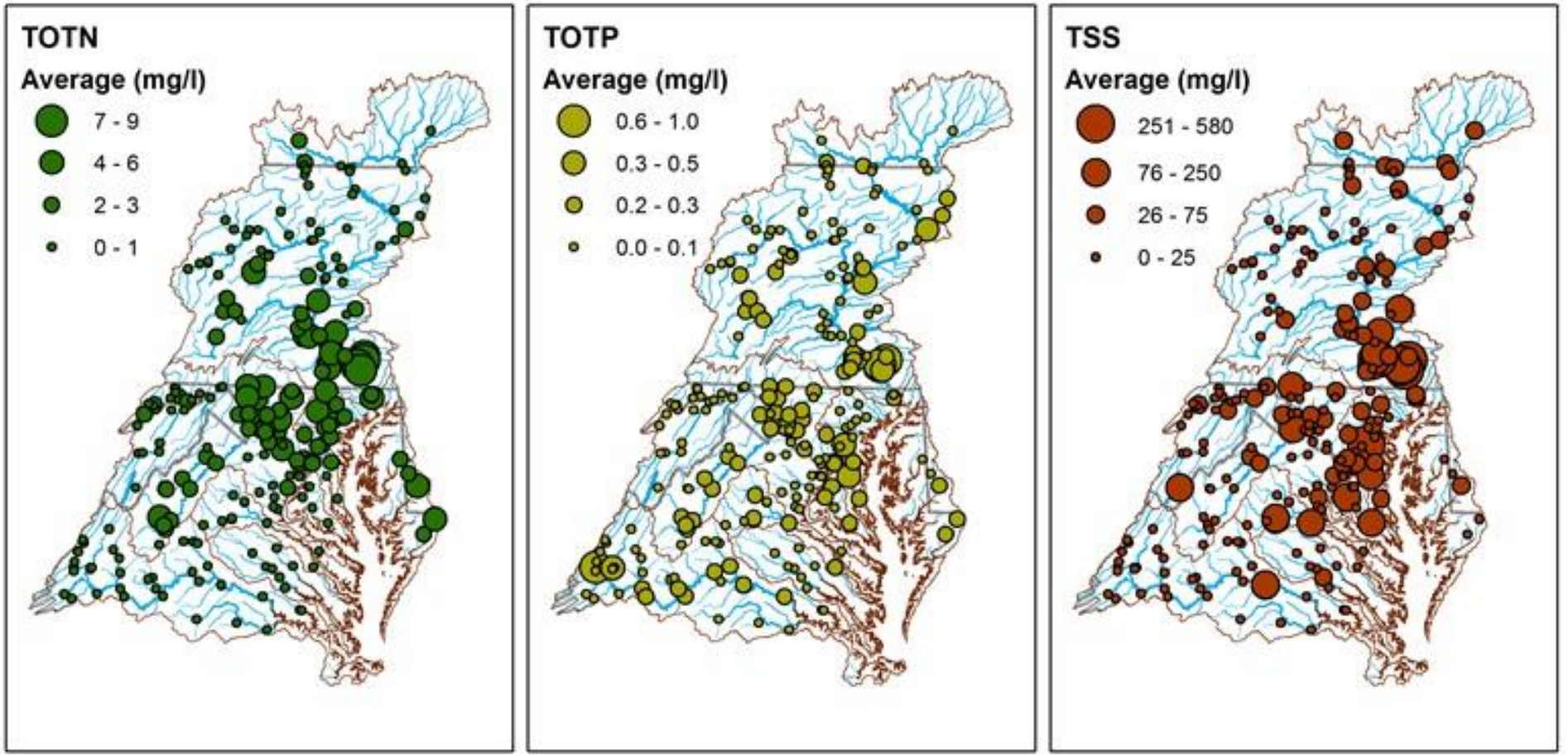
… but does it work?

Compare

Heavily-Calibrated Phase 5.3.2

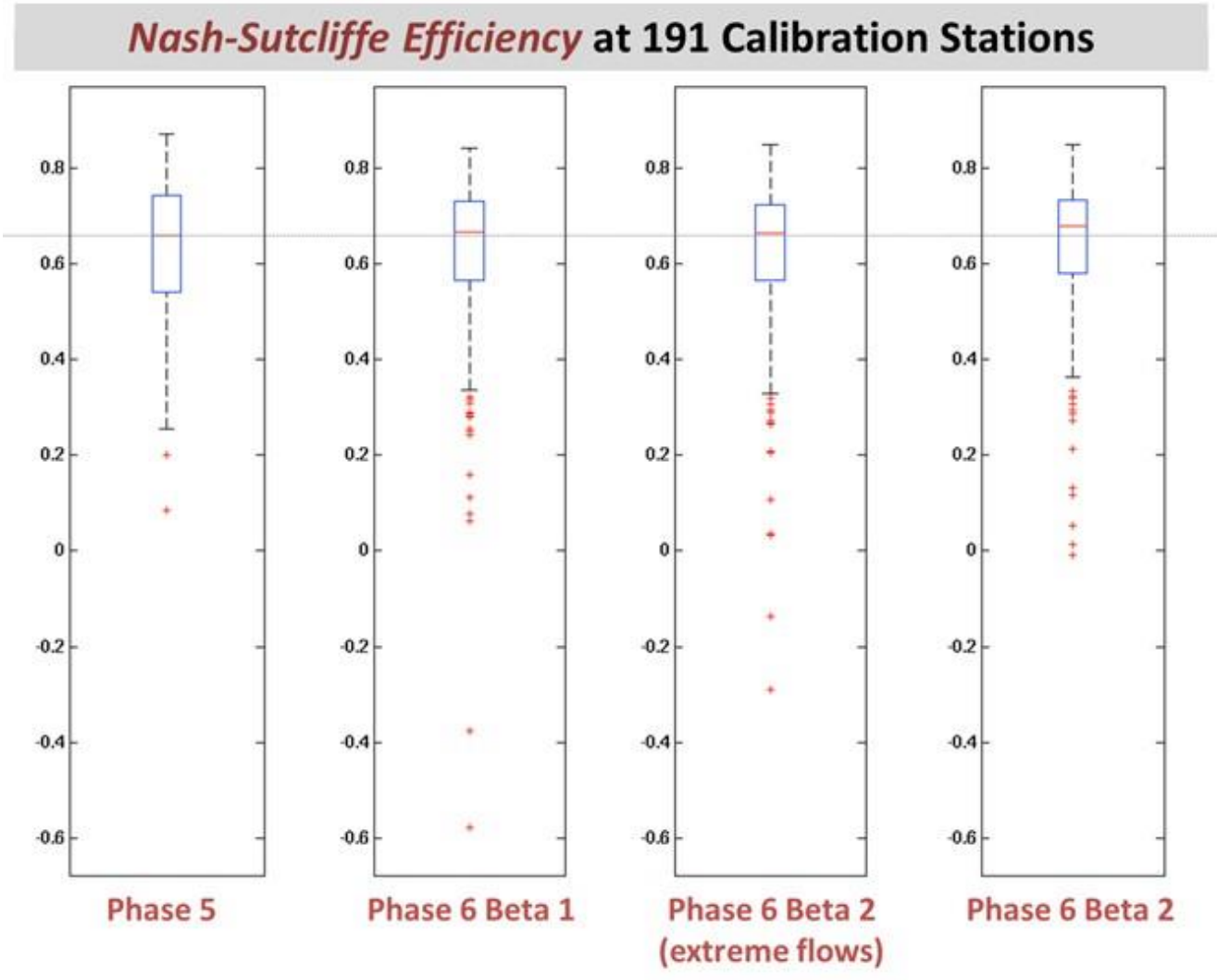
Lightly-Calibrated Phase 6

Monitoring Stations



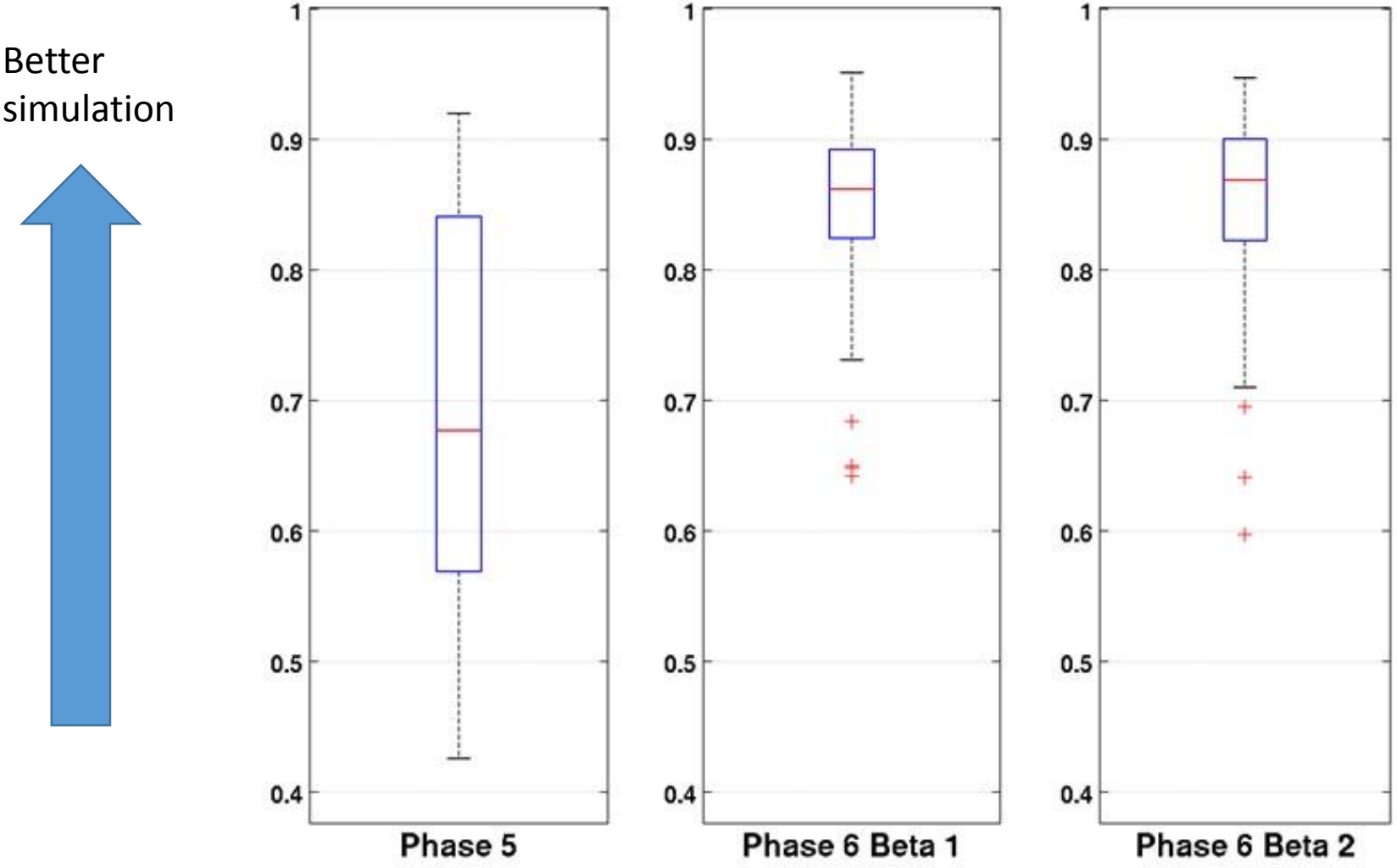
Hydrology

Better simulation



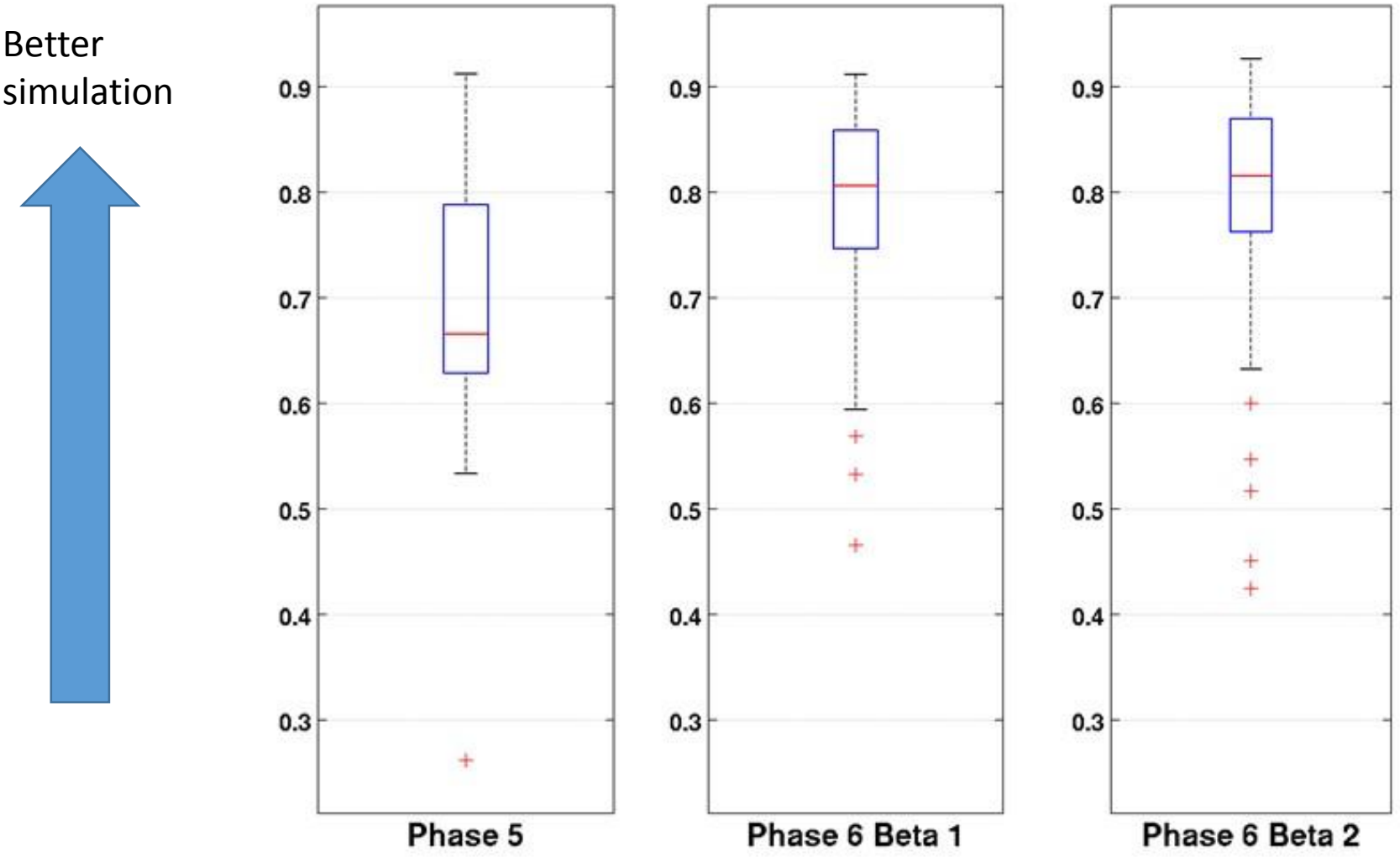
Nitrogen Seasonal Correlation

Better simulation



Phosphorus Seasonal Correlation

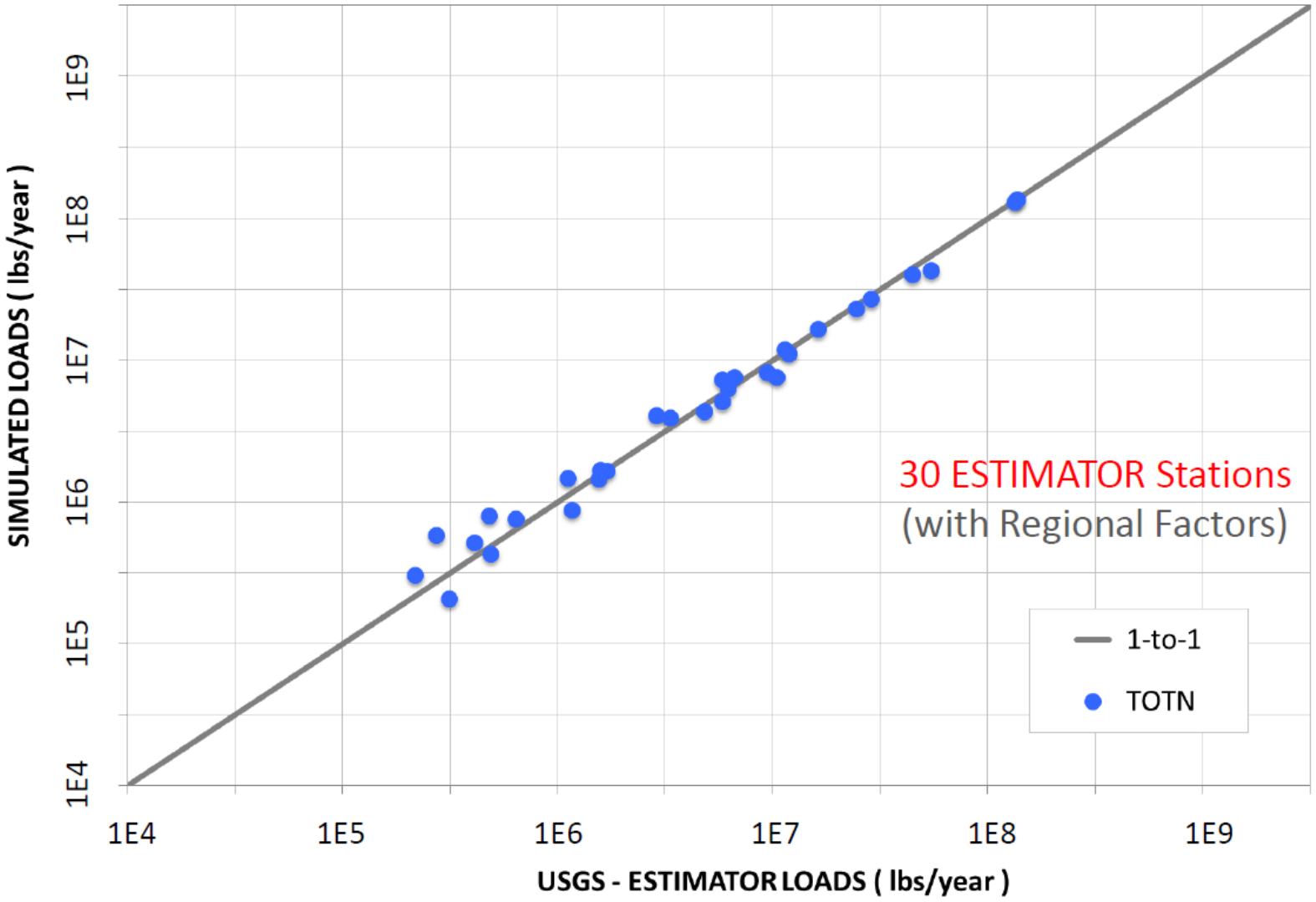
Better simulation



PHASE 5

NITROGEN

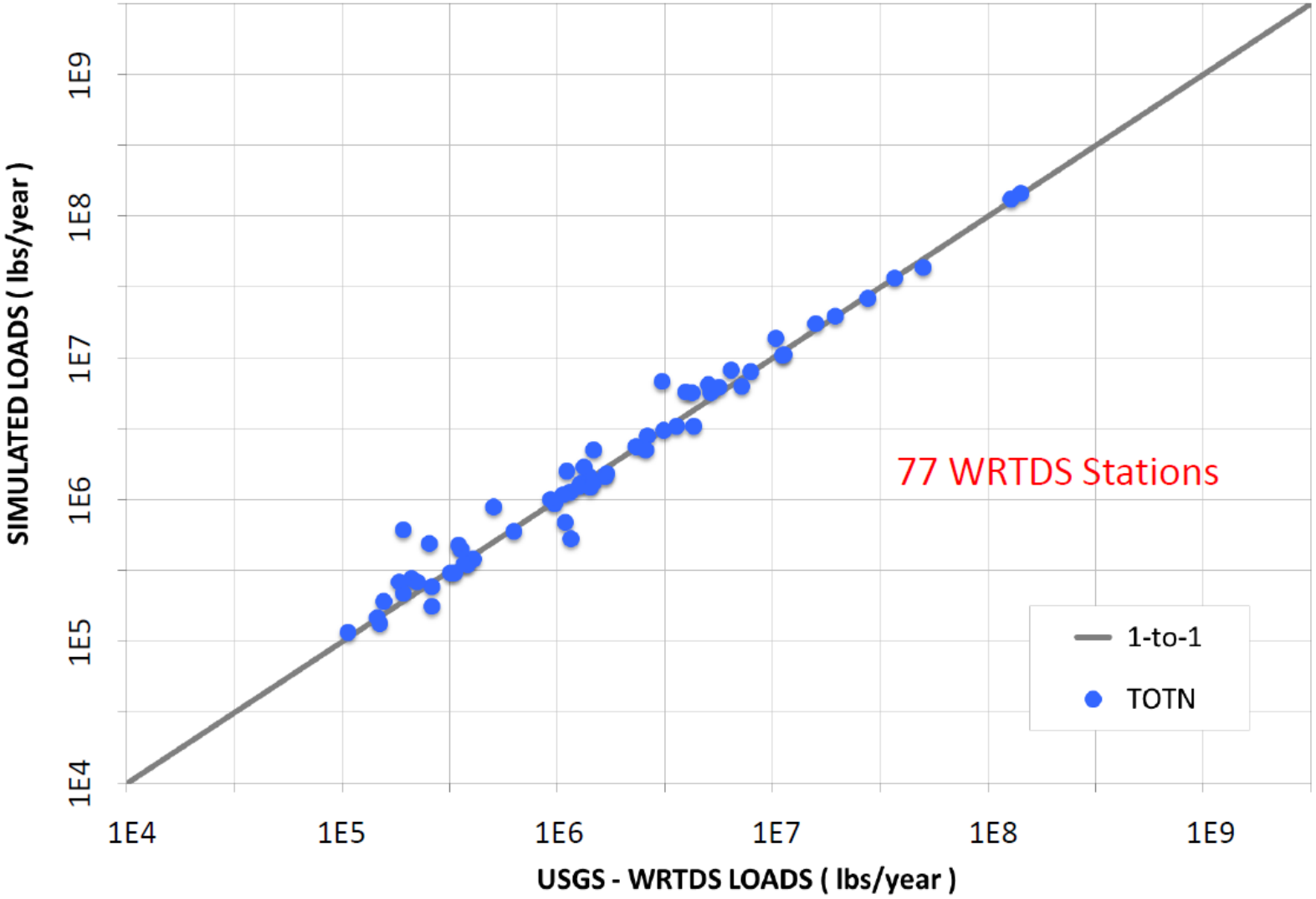
Load



PHASE 6
BETA 2

Load

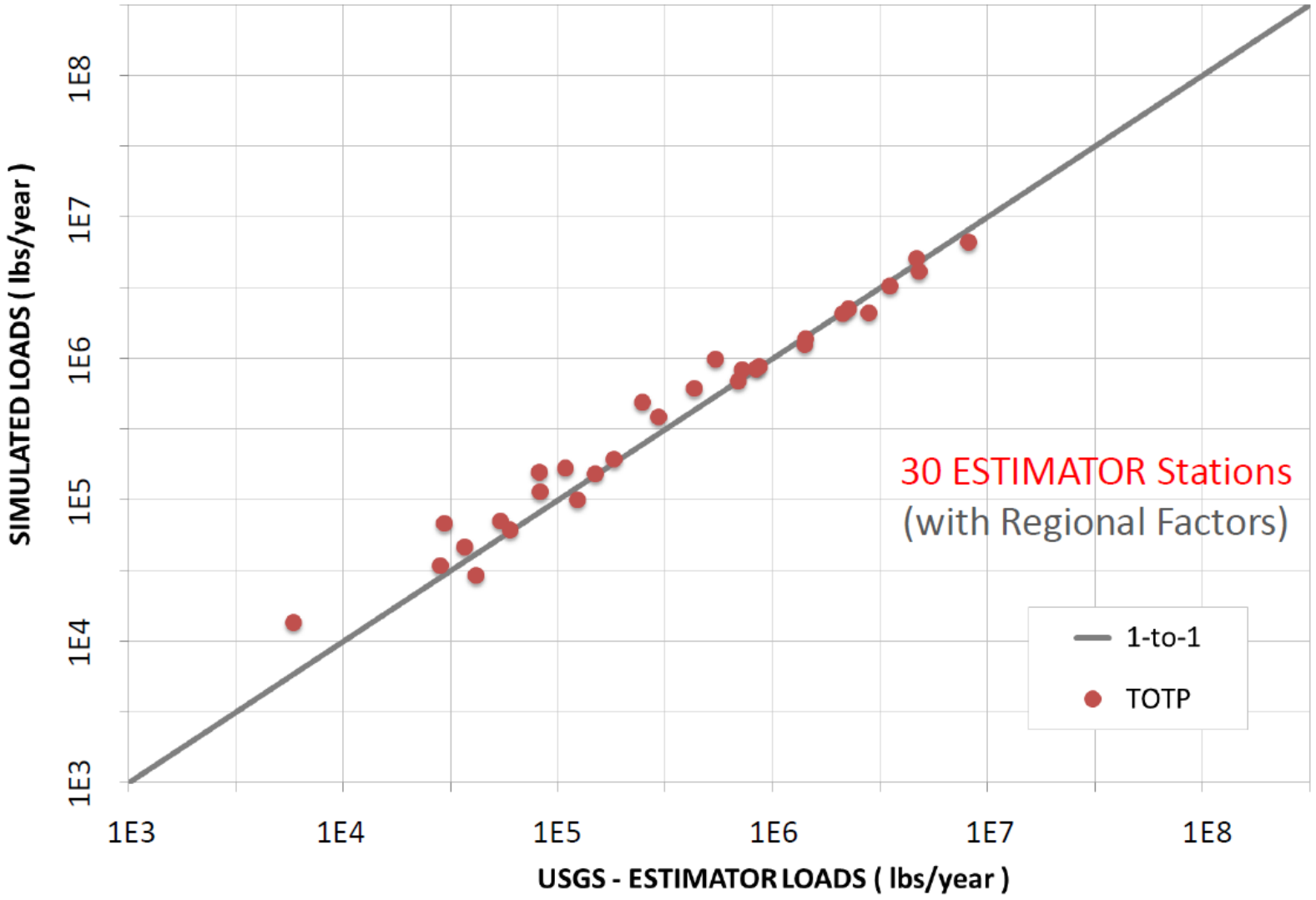
NITROGEN



PHASE 5

PHOSPHORUS

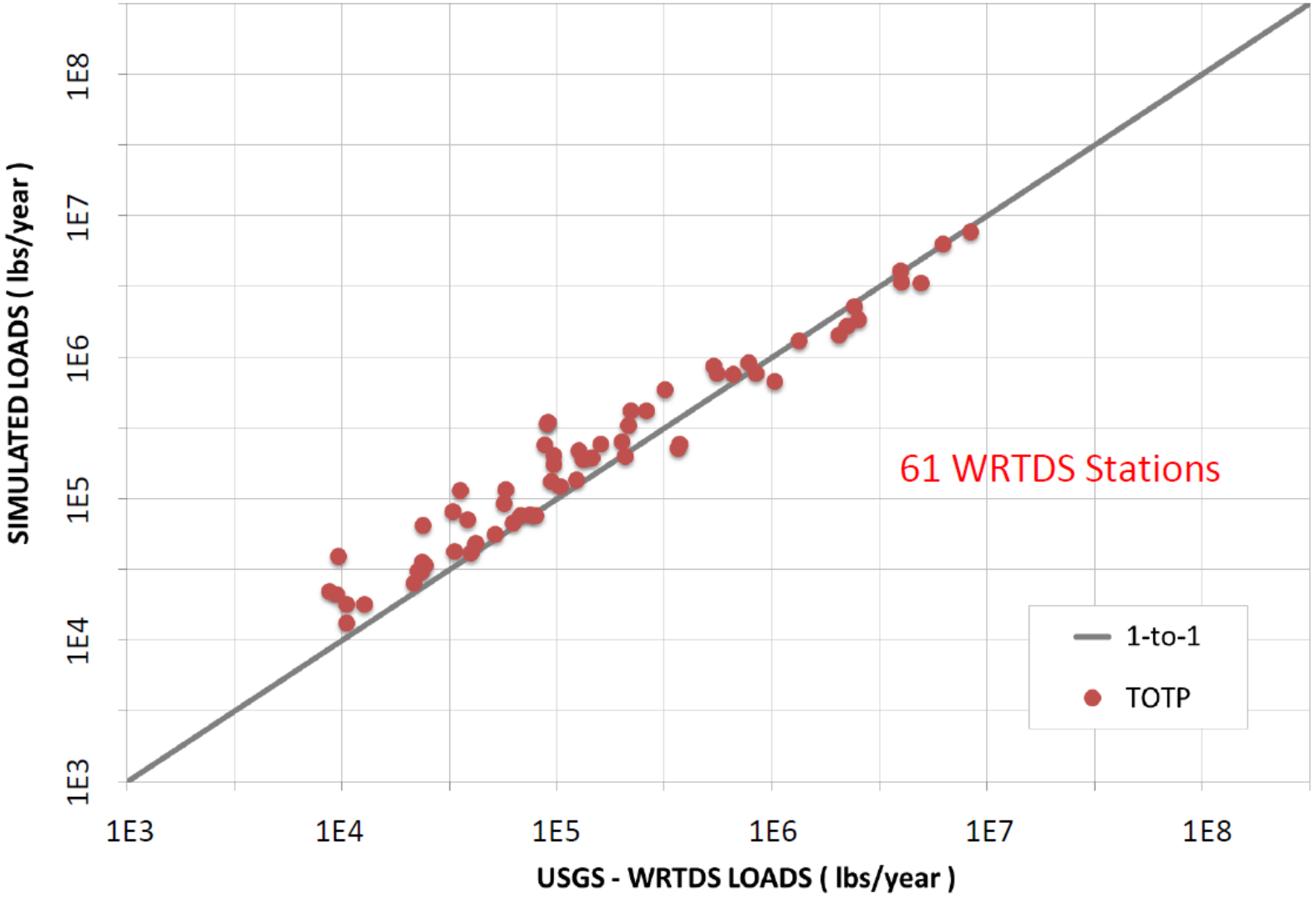
Load



PHASE 6
BETA 2

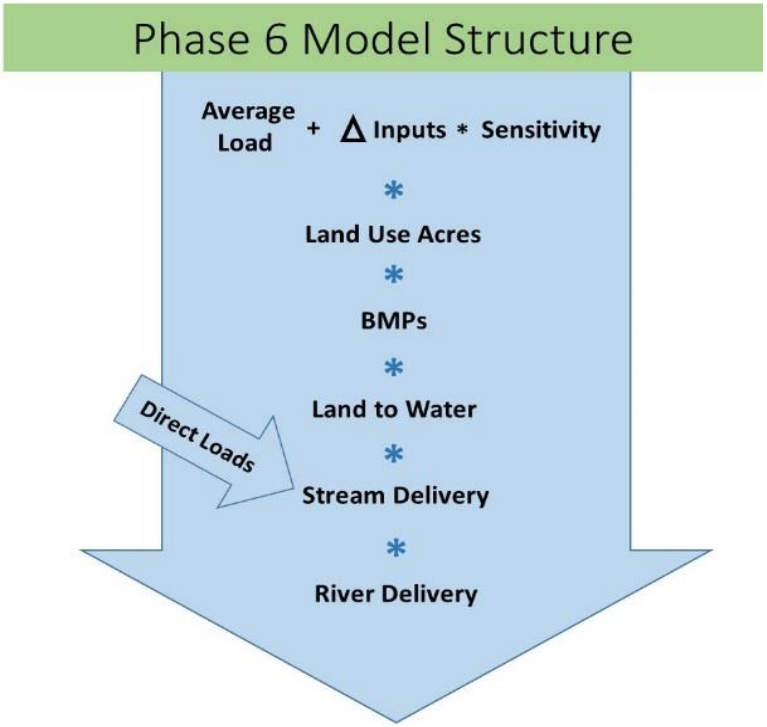
PHOSPHORUS

Load

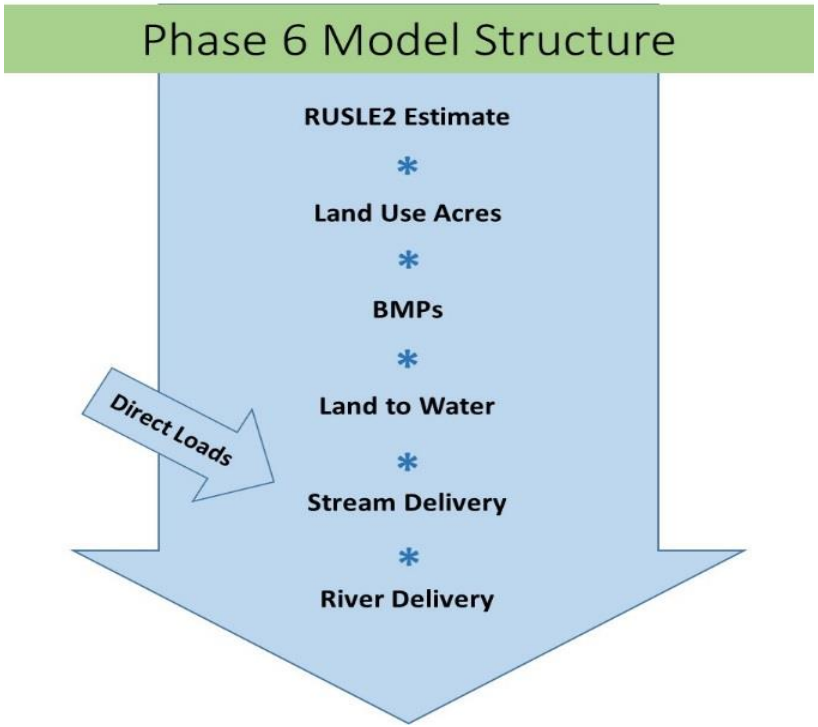


Sediment is similar to nutrients but no sensitivity

Nutrients

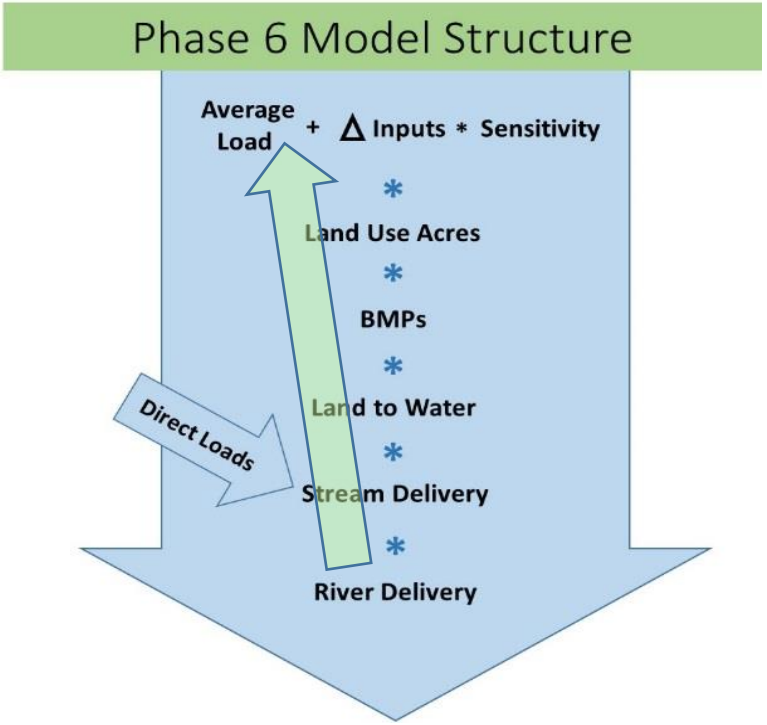


Sediment

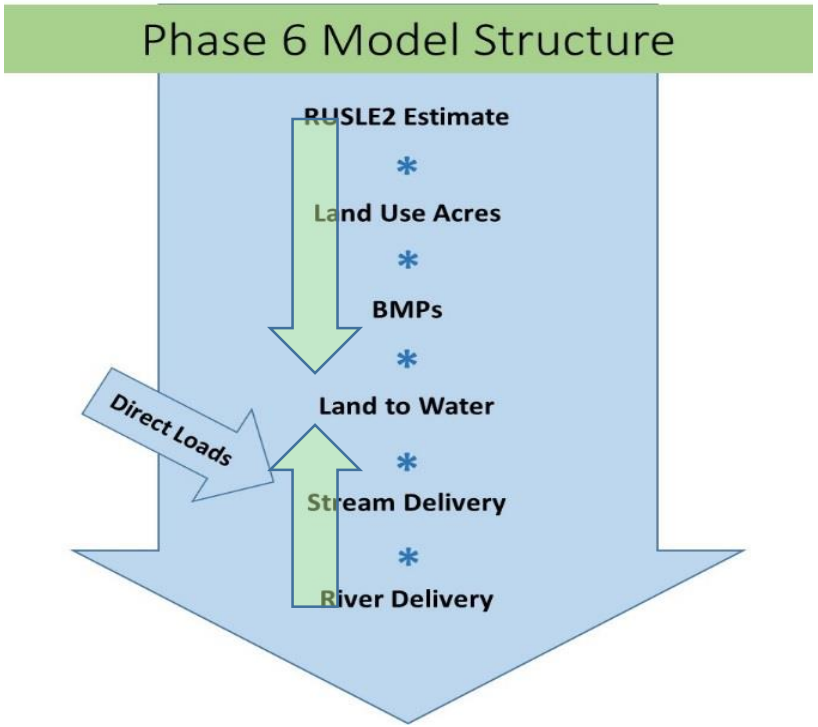


Mass Balance at the L2W step rather than the average load step

Nutrients



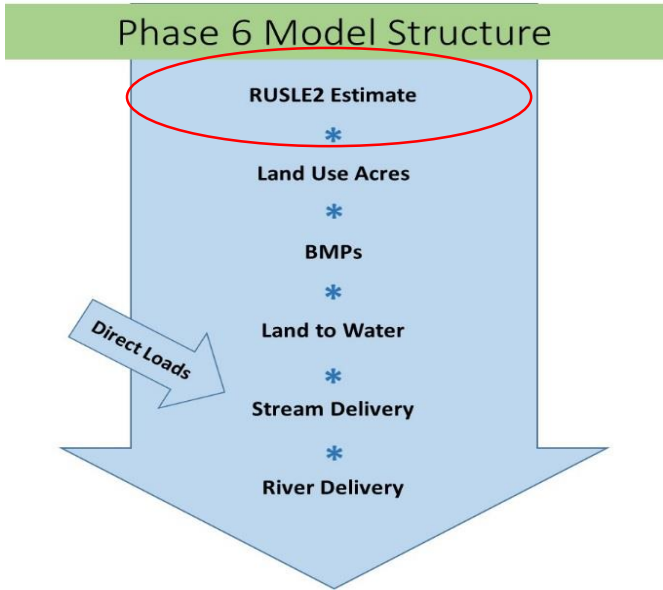
Sediment



Beta 2

RUSLE2 = Edge-of-Field Loads

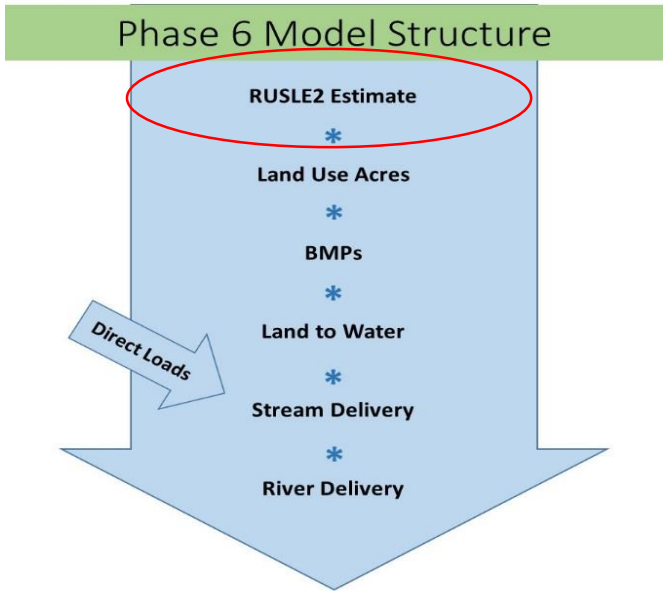
- Evaluated at the 10m Pixel Level
- Summarized to LRseg and land use
  - Forest
  - Open Space
  - Crop
  - Pasture
  - Turfgrass
  - Tree Canopy over Turfgrass



RUSLE2 => A = RKLSCP

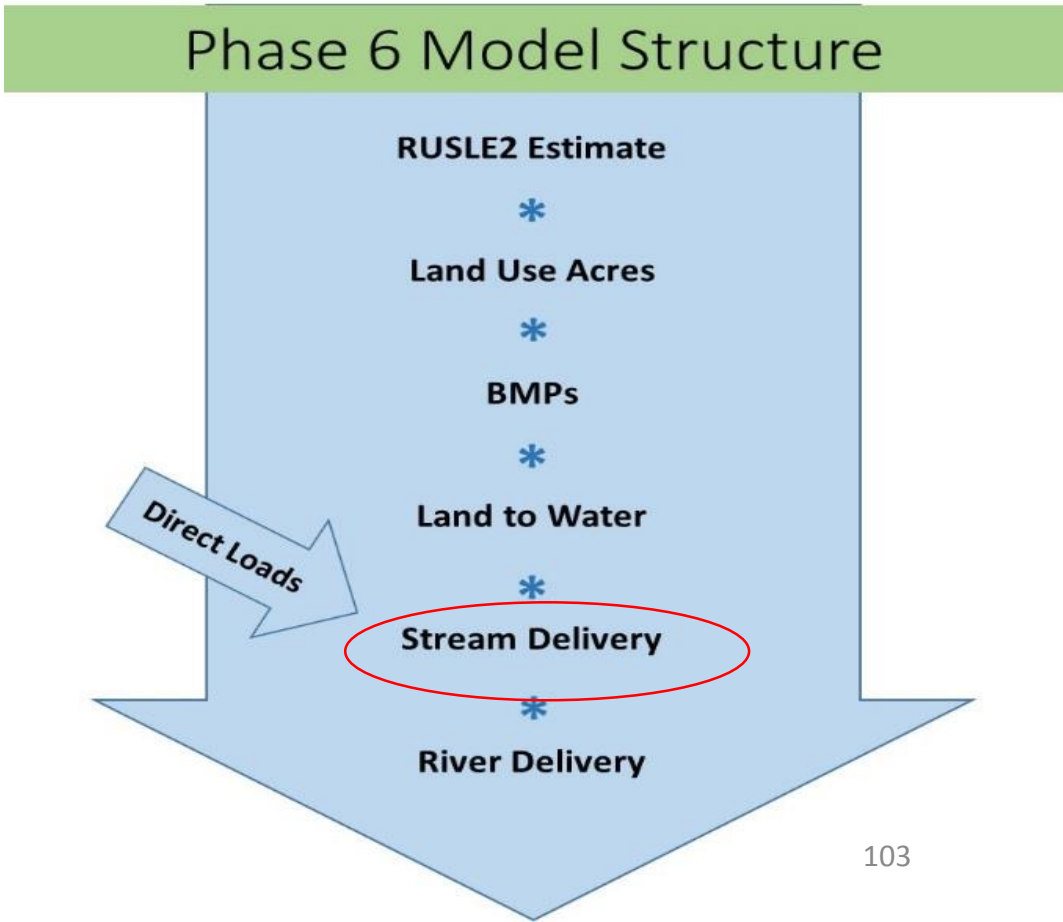
Beta 2

- R = Runoff
  - = $1.24P^{1.36}$ P from PRISM
- K = Erodibility
  - from STATSGO and gSSURGO
- LS = slope length
  - = (Flow Accumulation x Cell Resolution / 22.1)$^{0.4}$ x (Sin(Slope x 0.01745) / 0.09)$^{1.4}$ x 1.4
- C = Cover
  - from Tetratech and AgWG
- P = Practice
  - = 1 since no action loads



Stream Delivery – Ag and Natural

- Will be Greg Noe / Peter Claggett stream mass balance
- Assumed to be 1 until completed



Beta 2

Stream Delivery – Developed

- Center for Watershed Protection Work

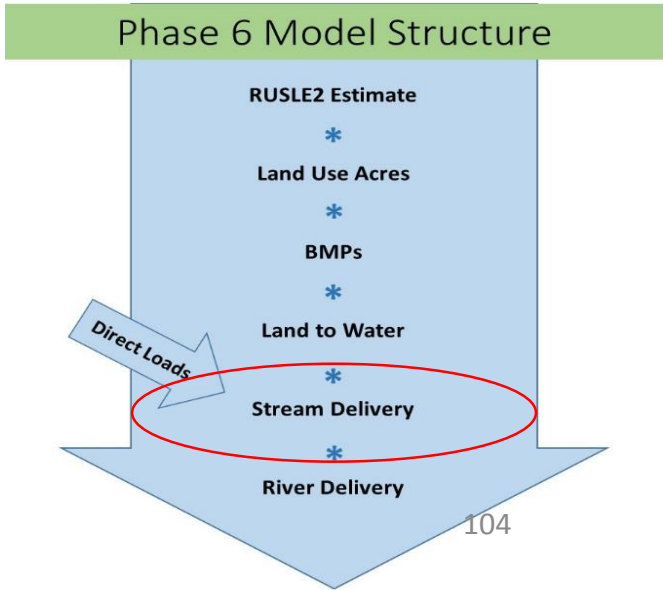
$$SSR = 1 - \frac{Upland\ Load}{Total\ Watershed\ Load}$$

Stream Source Load = Land Source Load * SSR / (1 – SSR)

SSR = 1.4085 * (fraction Impervious)

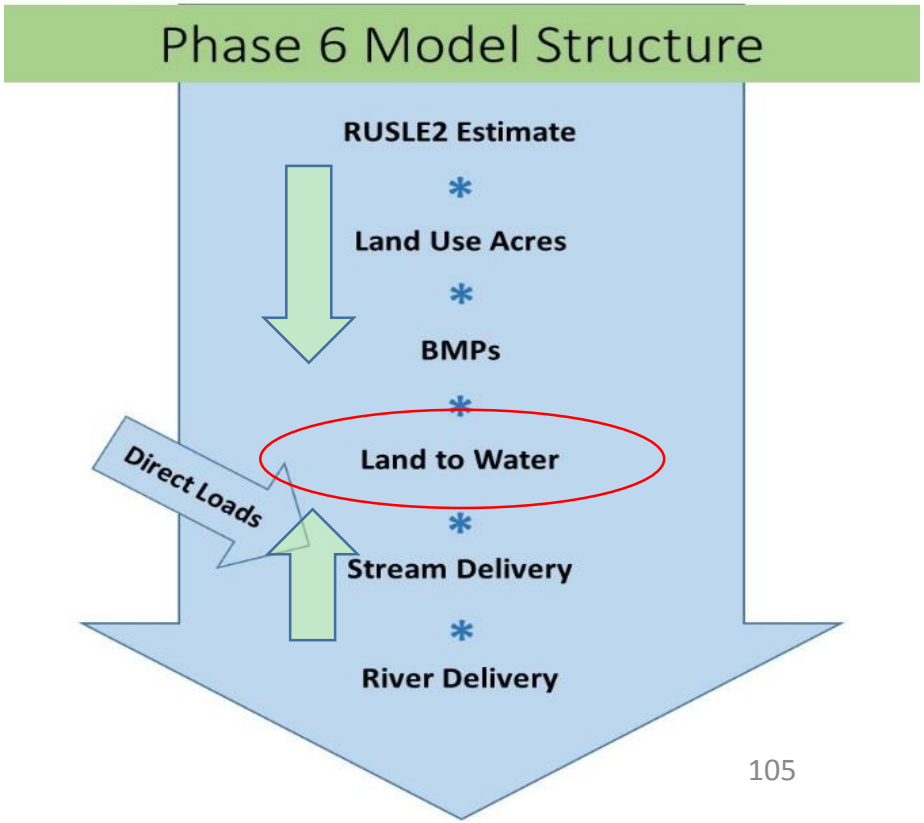
+ 0.5341 * (fraction CD soils)

- 0.2828



Land to Water – calculate average

- [(RUSLE2 * acres * BMPs * L2W) + SD] * RD = RIM Load
- L2W = [(RIM / RD) - SD] / (RUSLE2 * acres * BMPs)
- L2W = 0.25

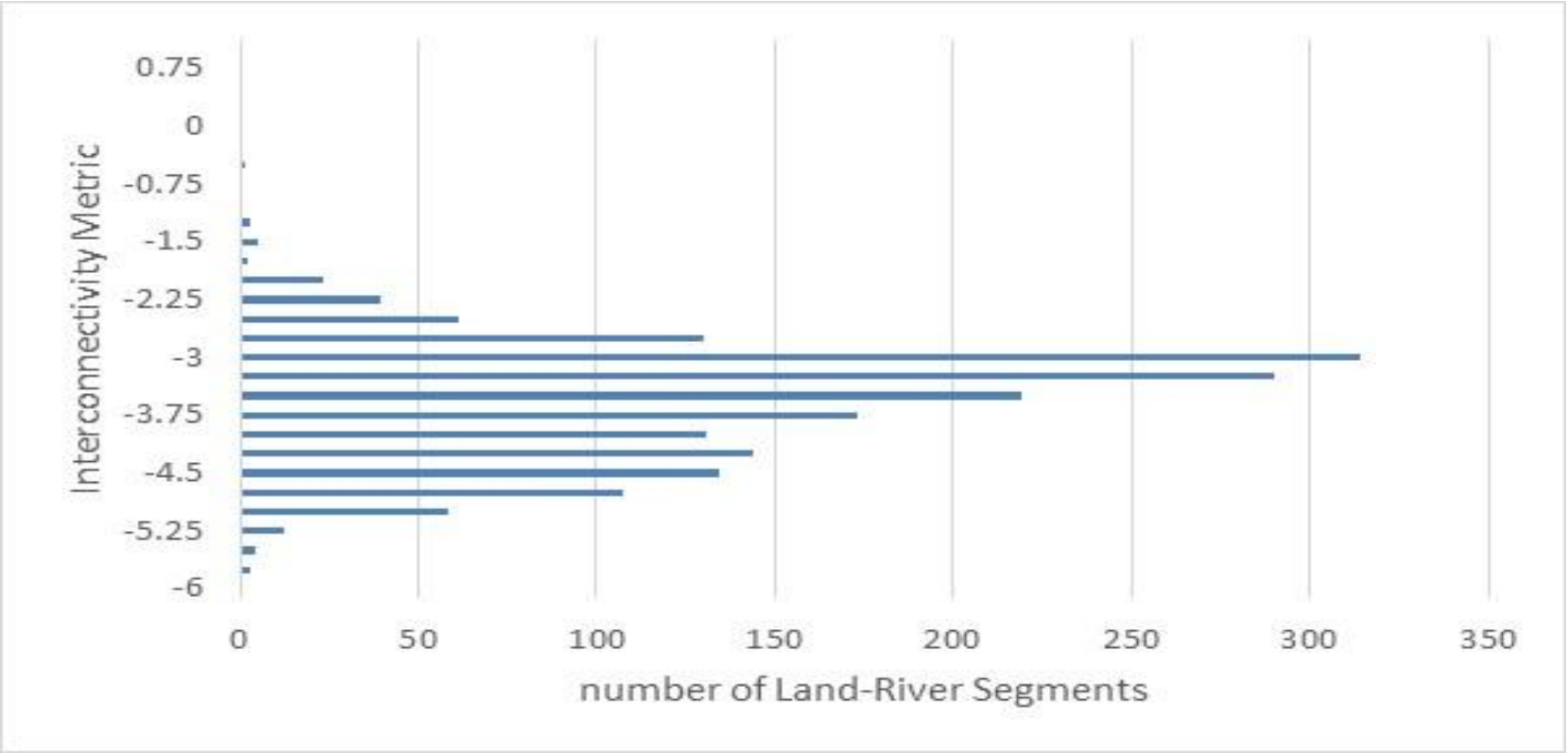


Beta 2

Interconnectivity Metric

Beta 2

Calculation related to Slope, Area, Flowpath Length, and Roughness

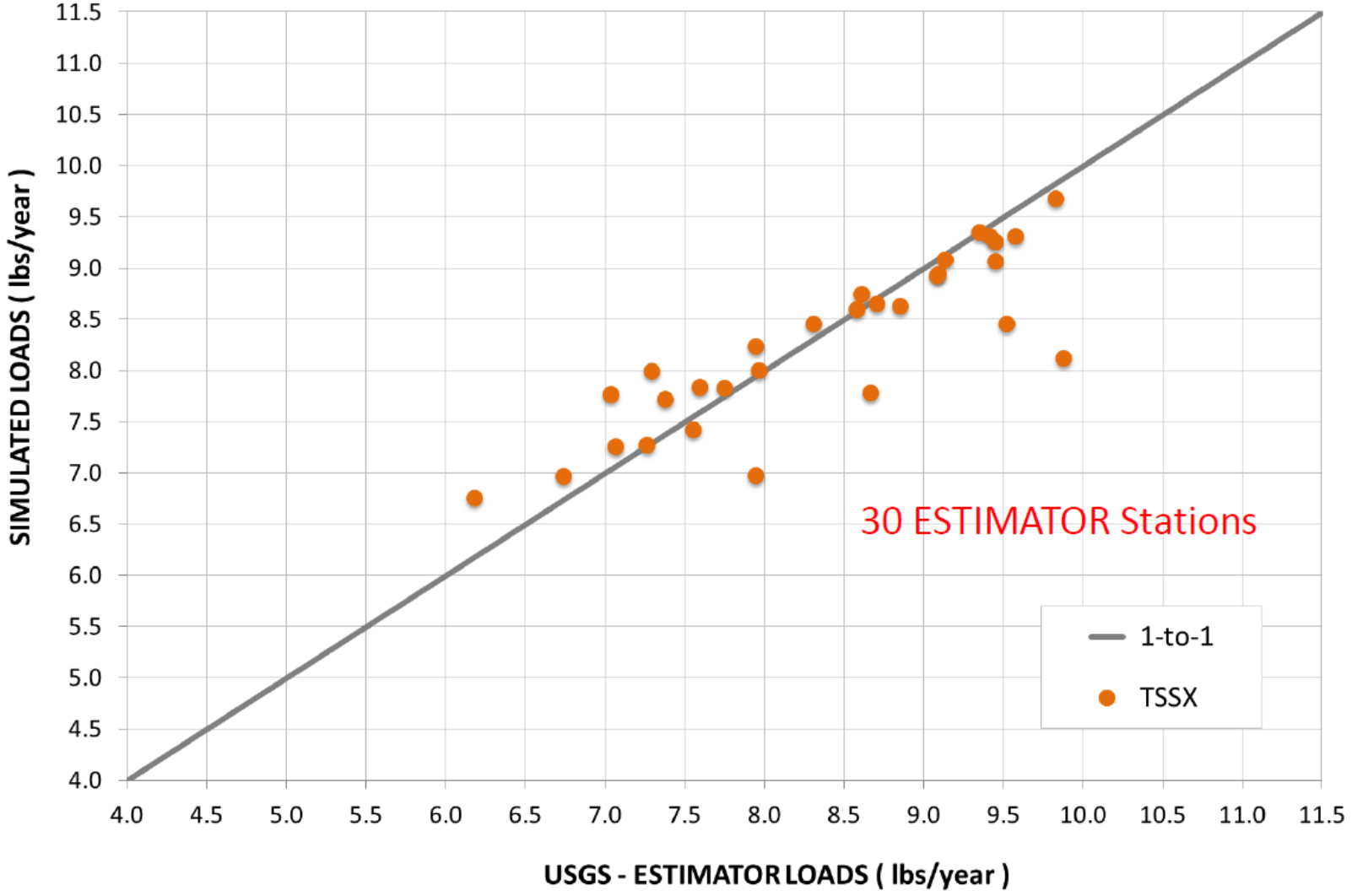


Peter Claggett and David Saavedra (UMBC)

PHASE 5

SEDIMENT

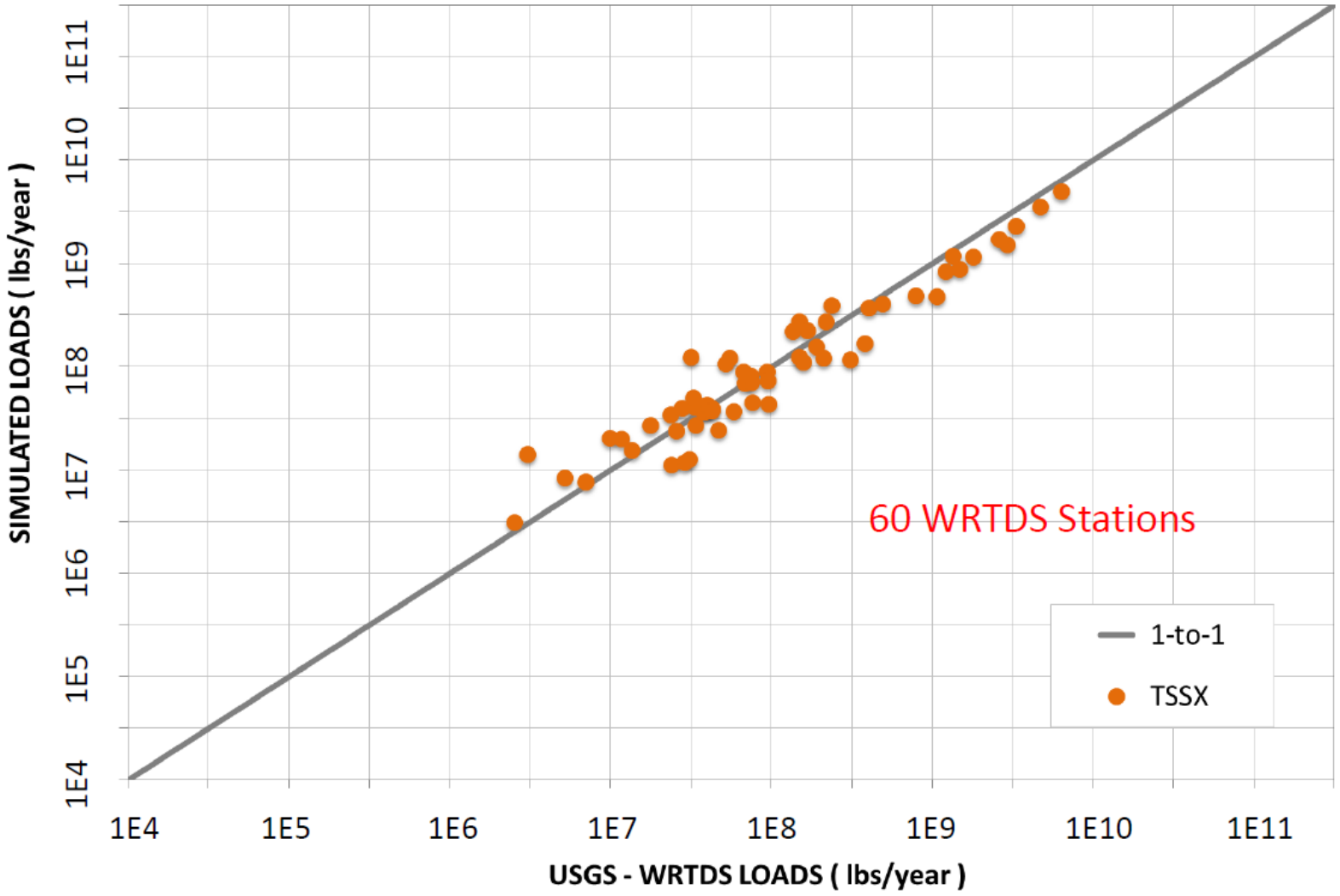
Load



PHASE 6
BETA 2

SEDIMENT

Load



Non-Tidal Water Quality Dashboard | WRTDS/WSM Dashboard

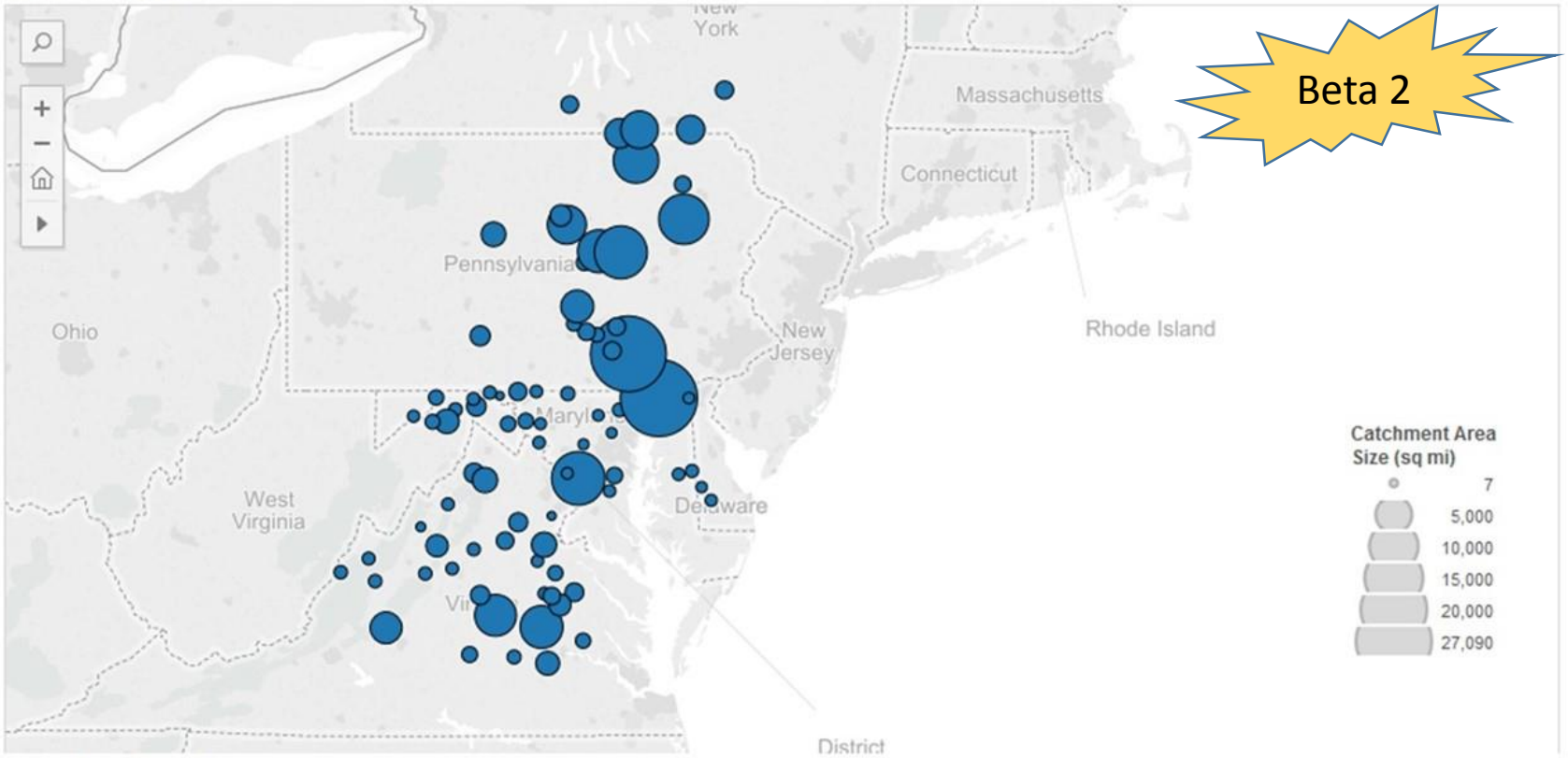
Chesapeake Bay Non-Tidal WRTDS/WSM Data

Select a parameter from the dropdown menu, then select a monitoring station from the map. The WRTDS and WSM values will be shown on the chart below. More information on the Watershed Model can be found at: http://www.chesapeakebay.net/groups/group/modeling_team

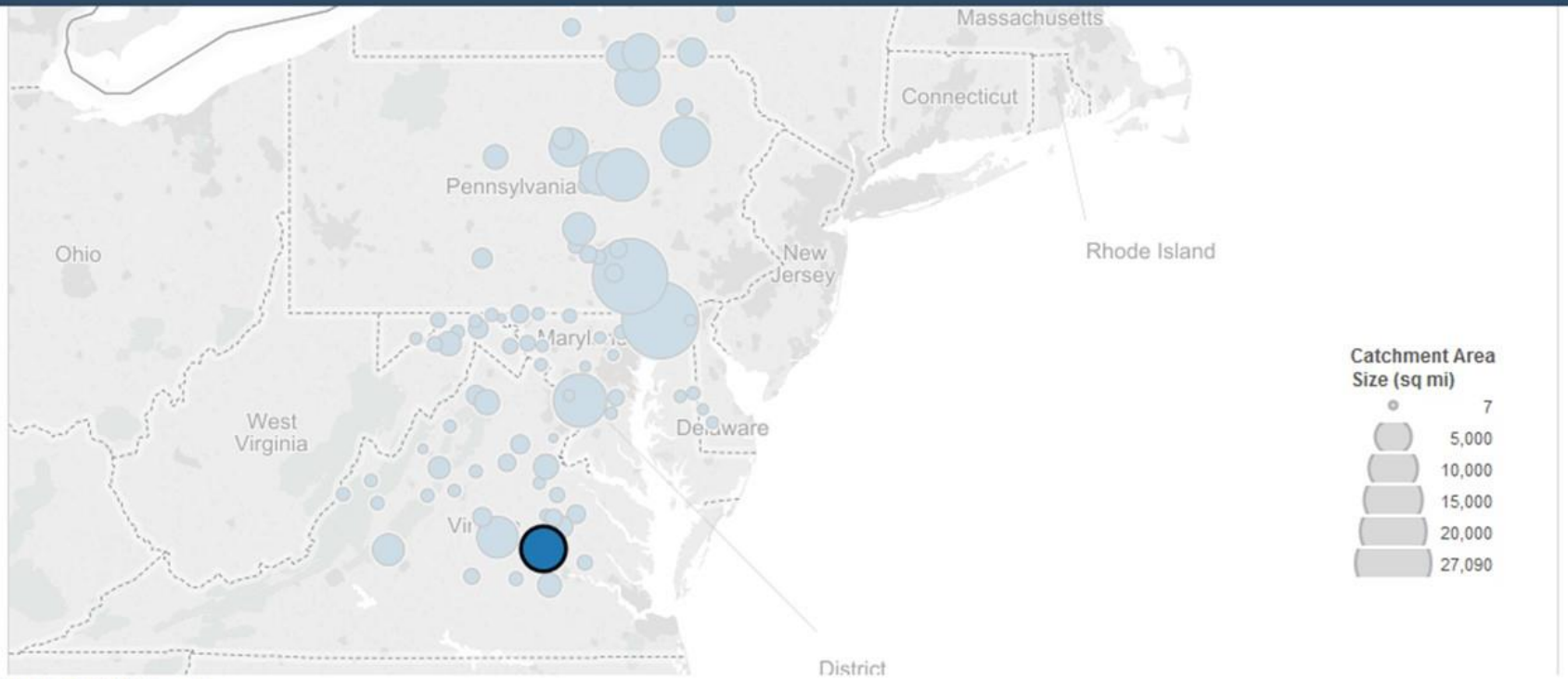
Parameter

Total nitrogen

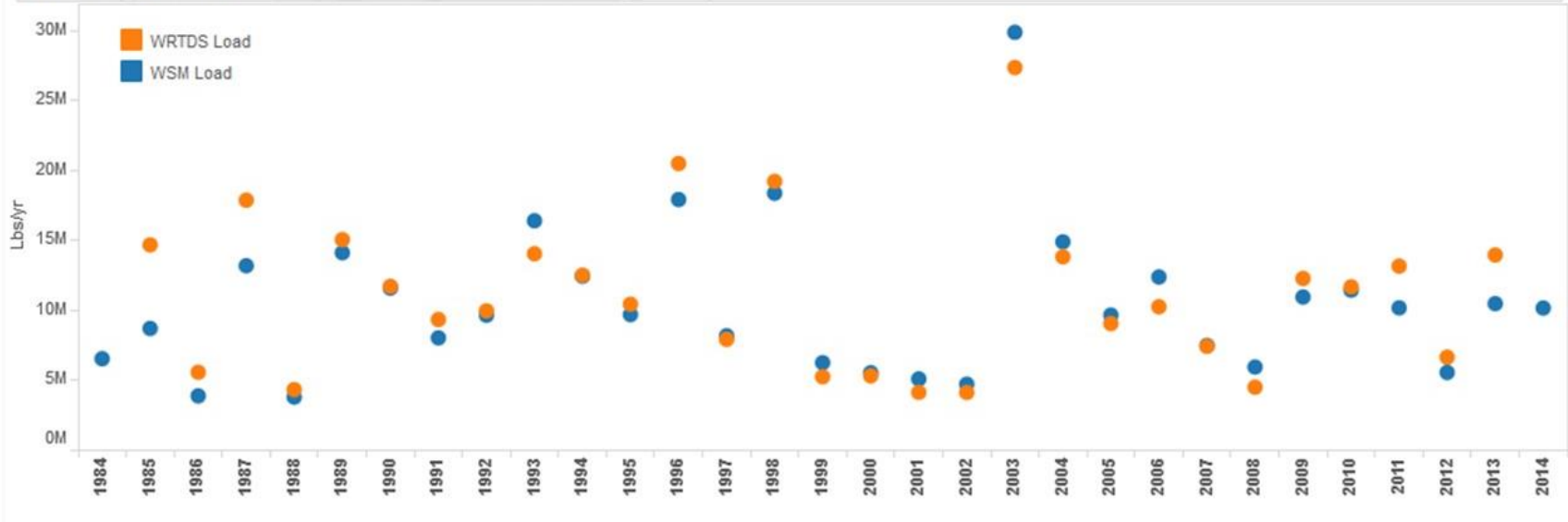
Non-tidal Stations



WRTDS/WSM Loads



WRTDS/WSM Loads



Beta 3 updates - August

- Overall Calibration Strategy
  - Examining assumptions throughout model
- Inputs
  - Update nutrient input data methods
  - Biosolids as a separate input
- Watershed representation
  - 8 new impoundments and reservoirs
  - rSAS model for simulating groundwater nitrate lags
- Scenarios – a few key scenarios

Beta 4 updates - December

- Overall Calibration Strategy
  - Examining assumptions throughout model
- Inputs
  - Updated nutrient inputs
  - Atmospheric deposition dataset
  - BMP history
  - BMP effects
- Watershed representation
  - Streambed and Shoreline loads
  - Representation of Conowingo
  - rSAS model for simulating groundwater nitrate lags
  - Updated Sparrow factors
- Scenarios – climate change

Phase 6 updates – April 2017

- Inputs
  - Land use

… and that's it

Review Strategy

- Read section 1 of the documentation to understand the overall structure
  - Determine the sections in the documentation that are most relevant to your work or interest in the Chesapeake Bay Program partnership.
- Review sections of interest to comment on
  - Quality of documentation
  - Overall concept used to calculate model values
  - Calculation methods used to determine model values
  - Data used
  - Long-term suggestions for future models.
- Review the calibration relative to concentrations and loads
  - Summary flow statistics
  - Summary of agreement between WRTDS and Phase 6 overall
  - Review particular stations of interest to your jurisdiction.
- Review scenarios (B3, B4)
  - Broad Scale – Relative ranking of scenarios
  - The aggregate effect of BMPs
  - The effects of inputs, such as land use, animal numbers, etc.

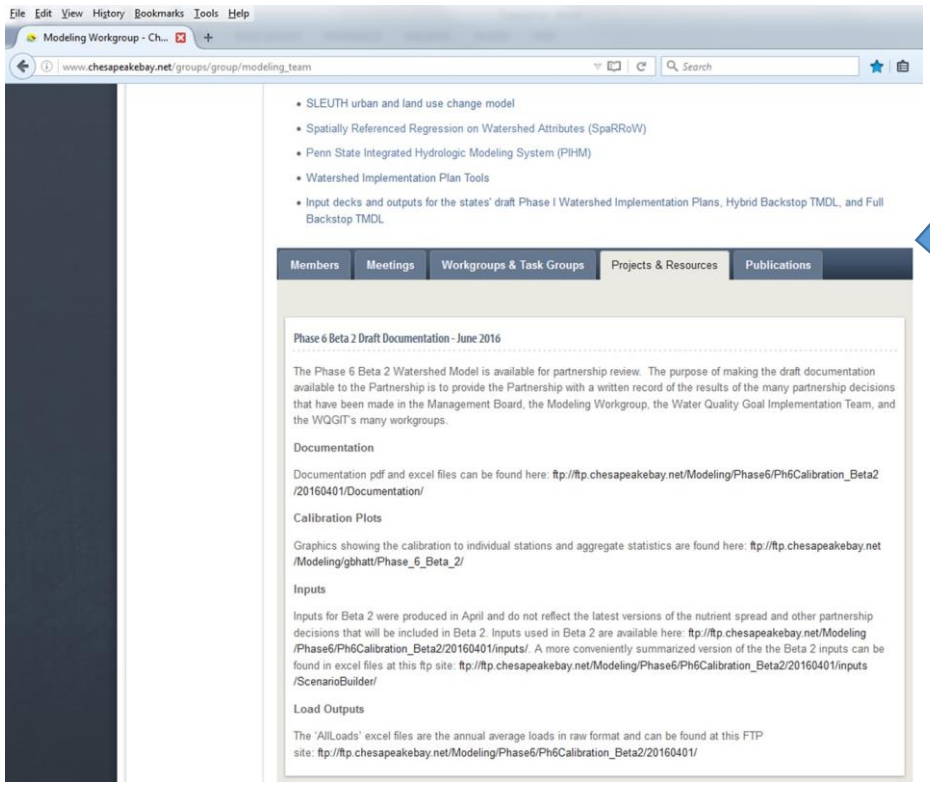
Evaluation Focus – Model Performance

- Is the model simulating the processes correctly?
- Is the model performing reasonably with respect to observations?
  - RIM stations, large watersheds to smaller
  - Annual loads
  - Seasonal performance
  - B1 vs. P5, B2 vs. B1, B3 vs. B2…..
- Model trends vs observed trends
- How is the model performing in management scenarios?
  - Are BMPs reducing loads? sounds simple, but important
  - Do the ordinal ranking of scenarios make sense?
- Temperance, not perfect but reasonable

How to get more information

Modeling Workgroup website on Chesapeakebay.net

Scroll down to
'projects & resources' tab



Set up a state-specific meeting

Discussion……